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CREW SCHEDULING OF SPACE OPERATIONS SQUADRONS (SOPS)

THESIS

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THESIS

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Preface

The mission objective of Space Operations Squadrons is continuous support of military satellite systems. The first problem associated with conducting continuous satellite support operations is finding cyclical crew shift schedules that meet daily workforce manning requirements, adhere to current regulations, contain a minimum number of workshift changes during consecutive duty days, and maximize the non-duty time allowed between duty shifts. The second problem is to establish a set of criteria to evaluate alternative shift schedules. Finally, the third problem is to minimize the number of personnel required to meet the scheduling requirements stated in the first problem.

This study developed mathematical relationships that led to an approach for generating cyclical crew shift schedules. This method was then used to generate an alternate crew shift schedule which was compared to the current schedule using a set of criteria developed for determining the effectiveness of a schedule. This study also tested if non-crew scheduling could reduce the number of people needed to support satellite operations. Non-crew scheduling was modeled as a set covering problem. The set covering method shows that the scheduling requirements can be met using a smaller number of personnel.

To meet the objectives of this study I was assisted by a number of people whom I wish to express my deepest appreciation. I wish to thank the First Space Operations Squadron for providing me with data to this research. A very special thanks to Captain Fetter who was my point of contact at the 1SOPS. He introduced me to the operations staff and ensured I was given information pertinent to my research.

I especially wish to thank my advisors, Major Borsi and Lt. Colonel Moore for their numerous suggestions and constructive criticisms; and for their guidance and patients throughout this project.

Marianne Idzi

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Abstract

The day-to-day mission objective of Space Operations Squadrons (SOPS) is to support military satellite systems. It is essential for these military satellite systems to operate twenty-four hours-a-day, seven days-a-week. The scheduling problem associated with conducting continuous satellite support operations for SOPS is threefold. The first problem is finding cyclical crew shift schedules that meet daily workforce manning requirements, adhere to current AFSPACECOM regulations, contain a minimum number of workshift changes during consecutive duty days, and maximize the non-duty time allowed between duty shifts. The second problem is to establish a set of criteria to evaluate alternative shift schedules. Finally, the third problem is to minimize the number of personnel required to meet the scheduling requirements stated in the first problem.

This study developed mathematical relationships that led to an approach for generating cyclical crew shift schedules. This method was used to generate an alternate crew shift schedule. The alternate shift schedule was compared to the current schedule using a set of criteria developed for determining the effectiveness of a schedule. Using these criteria, the alternate schedule is better than the current schedule used by the First Space Operations Squadron (1SOPS).

In addition, this study tested if non-crew scheduling could reduce the number of people needed to support satellite operations. Non-crew scheduling was modeled as a set covering problem. This approach was best suited for scheduling the Crew Commander position. The Crew Commanders are qualified to support specific satellite programs; thus, it is more difficult to manually schedule this position. Currently, the 1SOPS uses forty-eight Crew Commanders to support its shift schedule. The set covering method shows that the scheduling requirements can be met using a total of thirty-six Crew Commanders.

CREW SCHEDULING OF SPACE OPERATIONS SQUADRONS (SOPS)

Chapter I

1. Introduction

The purpose of personnel scheduling is to allocate people to meet the workforce requirements that are vital to an organization's day-to-day operations. The day-to-day mission objective of Space Operations Squadrons (SOPS) is to support military satellite systems. It is essential for these military satellite systems to operate twenty-four hours-a-day, seven days-a-week. The personnel assigned to Space Operations Squadrons ensure the operability of US military satellites by performing continuous satellite support operations.

1.1 Background

Air Force Space Command's (AFSPACECOM's) 50th Space Wing (SPW) is organized into seven Space Operations Squadrons. Each SOPS is responsible for the support of one or more military satellite programs. Their fundamental mission is to command and control US military satellites through ground antennas located around the world. Through these antennas, SOPS personnel provide the ground support necessary to maintain and ensure the operability of US-owned space vehicles. They monitor the health, status, and orbit position of each operational military satellite. When necessary, SOPS personnel adjust the satellite's orbit alignment to maintain maximum performance capability. They also correct, if possible, any malfunctions that occur on the satellite vehicle.

Each SOPS is manned with a designated number of personnel trained for satellite operations. The Chief of Operations in each squadron assigns these trained individuals to a permanent "crew." Then the Noncommissioned Officer-in Charge (NCOIC) of Scheduling Operations assigns the crews to support operations based on a cyclical crew shift schedule.

1.2 Cyclical Crew Shift Schedules

A cyclical shift schedule is a sequence of workshifts and off-shifts that repeat indefinitely. The three cyclical crew shift schedules described below have been used by Space Operations Squadrons. They are referred to as the 2/2/2/4 shift schedule, the 6/4 shift schedule and the 6/2 - 6/4 shift schedule. Each day of a shift schedule is divided into workshift and off-shift periods. Note that each day of the 2/2/2/4 shift schedule and the 6/4 shift schedule contains three workshift periods called day-shift (*D*), swing-shift (*S*), and midnight-shift (*M*); and every day of the 6/2 - 6/4 shift schedule is composed of two workshift periods called day-shift (*D*) and night-shift (*N*). On any day in the cycle, one crew must be assigned to each workshift period. A crew not assigned to a workshift has an off-shift. In each of the figures depicting shift schedules, off-shift are denoted by having no letter entry on that day of the cycle.

1.2.1 The 2/2/2/4 Shift Schedule. A crew that follows a 2/2/2/4 shift schedule progresses through its cycle as follows: two day-shifts, two swing-shifts, two midnight-shifts, and four off-shifts. Figure 1.1 illustrates one month's shift schedule using the 2/2/2/4 option.

	DAYS IN SCHEDULE																														
CREW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	D	D	S	S	M	M					D	D	S	S	M	M					D	D	S	S	M	M					D
2			D	D	S	S	M	M					D	D	S	S	M	M					D	D	S	S	M	M			
3					D	D	S	S	M	M					D	D	S	S	M	M					D	D	S	S	M	M	
4	M	M					D	D	S	S	M	M					D	D	S	S	M	M					D	D	S	S	M
5	S	S	M	M					D	D	S	S	M	M					D	D	S	S	M	M					D	D	S

Figure 1.1: 2/2/2/4 Shift Schedule

This schedule requires a total of five crews to support satellite operations. Thus, on any day in the cycle, three crews are assigned to workshifts and two crews are off duty. The shift cycle consists of six days of duty followed by four days of non-duty. During the six days of duty, a crew rotates through each of the three workshift periods. That is, a crew works two day-shifts, then rotates to the swing-shift for two days, and then rotates to the midnight-shift for two days. Thus, the 2/2/2/4 shift schedule requires a crew to change workshifts twice during a six day period.

1.2.2 The 6/4 Shift Schedule. Like the 2/2/2/4 shift schedule, the 6/4 shift schedule requires each crew to serve six days of duty followed by four days of non-duty. The difference is that each crew supports the same workshift period for six consecutive duty days as opposed to changing workshifts as in the 2/2/2/4 shift schedule. After completing the six days of duty, a crew has four off-shift days before starting the next set of duty days. The crew begins its next set of duty days by changing to a new workshift period. An example schedule using this type of shift schedule is presented in Figure 1.2.

	DAYS IN SCHEDULE																														
CREW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	D	D	D	D	D	D					S	S	S	S	S	S					M	M	M	M	M	M					D
2	M	M					D	D	D	D	D	D					S	S	S	S	S	S					M	M	M	M	M
3			M	M	M	M	M	M					D	D	D	D	D	D					S	S	S	S	S	S			
4	S	S	S	S					M	M	M	M	M	M					D	D	D	D	D	D					S	S	S
5					S	S	S	S	S	S					M	M	M	M	M	M					D	D	D	D	D	D	

Figure 1.2: 6/4 Shift Schedule

1.2.3 The 6/2 - 6/4 Shift Schedule. The 6/2 - 6/4 shift schedule requires each crew to have six consecutive same workshift periods followed by two off-shifts; then rotate to a new workshift period for six days followed by four off-shifts. Figure 1.3 shows an example of a 6/2 - 6/4 shift schedule that uses three crews and two workshift periods.

	DAYS IN SCHEDULE																														
CREW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	D	D	D	D	D	D			N	N	N	N	N	N					D	D	D	D	D	D			N	N	N	N	N
2	N	N					D	D	D	D	D	D			N	N	N	N	N	N					D	D	D	D	D	D	
3			N	N	N	N	N	N					D	D	D	D	D	D			N	N	N	N	N	N					D

Figure 1.3: 6/2 - 6/4 Shift Schedule

Each of the three cyclical crew shift schedules described in this section have been used by the First Space Operations Squadron (1SOPS). The 1SOPS is the primary source of information and data for this research.

1.3 The First Space Operations Squadron

1.3.1 The 1SOPS Organization. The 1SOPS is responsible for providing routine command and control support for three satellite systems: Defense Support Program (DSP), Defense Meteorological Satellite Program (DMSP), and Navstar Global Positioning Program (GPS). The squadron operates two control centers. Satellite Operations Complex 31-A, called SOC 31-A, which supports GPS and DMSP. SOC 31-B supports DSP and shares responsibility in the support of DMSP.

To fulfill its mission requirements, the 1SOPS needs a waiver to 50th SPW regulation 55-12. Regulation 55-12 requires twenty crew members to be on duty at any time during the day. Recent military force reductions and freezes on the amount of manpower allotted to each SOPS have caused the 1SOPS to restructure its crew force. Thus, the 1SOPS crew force is organized into five crews supporting both SOC 31-A and SOC 31-B. At minimum, each crew contains twelve crew members: a Flight Commander (FCMDR), seven Crew Commanders (CMDRs) or Deputy Crew Commanders (DCMDRs), and four Ground System Operators (GSOs).

1.3.2 1SOPS Concerns with Crew Shift Schedules.

1.3.2.1 The 6/4 Shift Schedule. The 1SOPS tried using the 6/4 shift schedule to meet its 24-hour-a-day support requirement. Although this shift schedule meets the daily operations requirements, it violates AFSPACECOM Regulation 55-16. Regulation 55-16 states that the maximum authorized non-duty period following four or more consecutive duty shifts is 96 hours (3:20). The 6/4 schedule gives crew members 120 hours of non-duty time between the end of the last day-shift and the start of the first swing-shift in the cycle. In addition, the 6/4 schedule gives the crew member another 120-hour off-shift period between the end of the last swing-shift and the start of the first midnight-shift.

1.3.2.2 The 2/2/2/4 Shift Schedule. The current 24-hour shift schedule used by the 1SOPS is the 2/2/2/4 shift schedule. The principal complaint of crews working this schedule is having two workshift changes within a period of six consecutive duty days. Each crew's cycle requires that they work two day-shifts, rotate to two swing-shifts, and then rotate to two midnight-shifts.

According to an article written by Gail Monroe on manpower scheduling, changing workshifts can cause "personnel adaptation problems." Documentation suggests that weekly changes in shifts cause difficulties in the ability for a shift worker to establish regular sleeping habits (9:12). Currently, no research has been conducted on the consequences of performing two workshift changes in a period of six consecutive days, but it may be reasonable to assume that the effect should be similar to that found in the study of weekly shift changes. Some companies requiring 24-hour operations have gone to assigning fixed forces to each workshift (9:12). This method of scheduling may be a solution for the non-military community, but it is not acceptable for the military. Requiring everybody to work all shifts promotes equality and reduces any perception of favoritism among crew personnel.

1.3.2.3 The 6/2 - 6/4 Shift Schedule. The 6/2 - 6/4 shift schedule complies with AFSPACECOM regulations; however, this schedule is not used often. AFSPACECOM regulations state that the normal duty workshift should not exceed eight hours, but 12-hour shifts may be authorized at the discretion of the SOPS Commander. The 12-hour shifts are used during specific occasions when workshift manning requirements increase. An example of such an instance is launch and early orbit operations. The five crews are reassigned to three crews which provide more manpower per workshift. The drawback of using this approach is having a single shift last twelve hours.

1.4 The Current Scheduling System

Three areas that the current scheduling system needs to address are 1) a way to generate alternative crew shift schedules; 2) a way to measure the effectiveness of shift schedules, and 3) a way to minimize the total number of personnel needed to support the shift schedules.

1.4.1 A Need to Generate Crew Shift Schedules. Currently, no methodical approach exists to generate cyclical crew shift schedules for the 1SOPS. The three SOPS shift schedules described in Section 1.2 were generated by trial and error. Using a pencil and paper, different shift scheduling options are examined until an acceptable schedule is found. Given specific objectives, requirements, and constraints, a scheduler should be able to generate, quickly and easily, a workable cyclical crew shift schedule.

1.4.2 A Need to Measure the Effectiveness of Shift Schedules. Currently, Space Operations Squadrons do not have a formal procedure for comparing crew shift schedules. For example, if a scheduler is able to generate several crew shift schedules, how does he/she select one crew shift schedule over another? Tangible criteria must be established to choose the best shift schedule. A schedule needs to insure that the SOPS current requirements for supporting satellites are met and that the schedule complies with applicable AFSPACECOM regulations and takes advantage of current waivers. The ideal schedule would also minimize the number of workshift changes a crew member must experience during a sequence of duty days. In addition, the ideal schedule would allow the maximum amount of non-duty time that is permitted by AFSPACECOM regulations.

1.4.3 A Need to Reduce the Size of the Crew Workforce. Recent reductions in manpower are a major concern of Space Operations Squadrons. The First Space Operations Squadron needs a waiver to the 50th Space Wing Regulation 55-12 which directs the manning

requirements for each SOPS. The most recent revision of the regulation, dated February 1992, requires assigning one-hundred people to the 1SOPS crew force (4). As of April 1993, the 1SOPS had eighty-two people assigned to its crews. Thus, another challenge to producing cyclical shift schedules is to find schedules that not only meet all support requirements, but also minimize the number of personnel needed to satisfy all support requirements.

1.5 Problem Statement

The fundamental scheduling problem with conducting 24-hour satellite support operations in the Space Operations Squadrons is threefold. The first problem is finding cyclical crew shift schedules that meet daily workforce manning requirements, adhere to current AFSPACECOM regulations and any existing waivers, contain a minimum number of workshift changes within a period of consecutive duty days, and maximize the non-duty time allowed between duty shifts. The second problem is how to choose the best schedule from a set of potential crew shift schedules. Finally, the third problem is to meet the scheduling requirements stated in the first problem using the smallest number of satellite support personnel possible.

1.6 Research Objectives

This research is designed to satisfy three objectives. The first objective is to be able to generate feasible crew shift schedules for Space Operations Squadrons given workforce requirements and scheduling constraints. This step requires establishing mathematical relationships inherent to cyclical crew shift schedules. The second research objective is to establish a set of criteria to compare crew shift schedules. The third research objective is to consider an unconventional approach to scheduling personnel for the Space Operations Squadrons. The purpose of this step of the research is to observe what effect individually scheduling SOPS personnel has on the total number of personnel needed to meet the daily satellite support requirements.

1.7 Research Constraints

Two Air Force publications are used to define the constraints of this research:

1) AFSPACECOM Regulation 55-16.

2) Waiver to 50th SPW Regulation 55-12.

1.8 Research Assumptions

Two assumptions made in this research are:

1) Shift workload remains constant throughout the day.

2) Crew Training Requirements were not considered.

1.9 Overview of the Remaining Chapters

Chapter II develops a number of pertinent mathematical relationships, such as the relationship between the number of workshifts per day and the minimum number of crews required to support the workshifts. Chapter III uses the relationships from Chapter II to develop a method to generate cyclical crew shift schedules. Then the method is redefined to provide a way to generate only the crew shift schedules that meet the requirements directed by Air Force scheduling regulations. Using parameters related to the current 2/2/2/4 shift schedule, an alternate cyclical crew shift schedule that simultaneously minimizes the number of workshift changes within a period of consecutive duty days and maximizes the amount of non-duty time allowed between duty shifts is created.

The second part of Chapter III is dedicated to establishing a set of measuring criteria to aid the scheduler in selecting the best schedule from the shift schedules generated. This set of criteria is then used to compare the alternate shift schedule that was created to the current crew shift schedule used by the 1SOPS.

Chapter IV introduces an alternate approach to personnel scheduling for Space Operations Squadrons. The chapter defines the set covering problem and provides a small example problem. Chapter V analyzes and presents the results from testing the set covering model using data collected from the First Space Operations Squadron and shift schedules generated for a 10-day cycle and a 25-day cycle.

The final chapter, Chapter VI, summarizes this research, provides conclusions about the research's results, and suggests further areas of study.

Chapter II

2. Cyclical Crew Shift Schedules

An essential step for creating a method to generate alternative schedules for satellite operations involves rigorously examining crew schedules. This is accomplished by developing a set of mathematical relationships which are generic among all cyclical crew shift schedules used in satellite operations. These mathematical relationships are the foundation for establishing the method shown in Chapter III for constructing alternative cyclical crew shift schedules.

2.1 Terminology and Notation

This section defines the terminology and notation that is used throughout this chapter.

1) Z represents the set of all integers and Z^+ represents the set of all positive integers.

2) A ***day*** is a 24-hour period of time.

3) A ***crew*** *is* a group of personnel assigned to work together. Any person allocated to work crew duty is assigned to only one crew. In this research paper, "*CR*" represents the *total number of crews* used to construct a crew shift schedule.

$CR \equiv$ *total number of crews,* where $CR \in Z^+$.

4) A ***workshift*** is an interval of time within a 24-hour period that is designated for a crew to be on-duty for work. For this research, the *number of workshifts per day*, "*WS*," is limited to two or three to comply with AFSPACECOM Regulation 55-16 (3).

$WS \equiv$ total number of workshifts per day, where $WS = 2$ or $WS = 3$.

According to AFSPACECOM Regulation 55-16, a normal workshift period requires eight hours of duty time; however, the squadron commander may extend the workshift period to twelve hours (3). This research will investigate workshift schedules containing "two 12-hour shifts" and "three 8-hour shifts" per 24-hour day. The 12-hour shift schedule contains two *workshift periods* known as ***day-shift*** and ***night-shift***. The 8-hour shift schedule contains three *workshift periods* called ***day-shift***, ***swing-shift***, and ***midnight-shift***. ***Off-shift*** is the term that is used to represent any 24- hour day in which a crew does not have duty on a workshift.

5) The term ***shift*** refers to either a workshift or an off-shift.

6) A ***cycle*** is a sequence of shifts which is repeated indefinitely.

7) The ***cycle length (CL)*** is the total number of consecutive days required to complete a sequence of shifts before the sequence repeats.

> ***CL ≡ total number of workshifts and off-shifts per cycle,***
> *where* $CL \in Z^+$.

8) For any crew working a crew shift schedule, the total number of "same" shift periods within a cycle is represented by the following notation:

> ***DS_i ≡ total number of day-shifts crew i works per cycle;***
>
> ***NS_i ≡ total number of night-shifts crew i works per cycle;***
>
> ***SS_i ≡ total number of swing-shifts crew i works per cycle;***
>
> ***MS_i ≡ total number of midnight-shifts crew i works per cycle;***
>
> ***OS_i ≡ total number of off-shifts crew i has per cycle;***
>
> where DS_i, NS_i, SS_i, MS_i, *and* $OS_i \in Z^+$ and $i = 1,2,\ldots, CR$.

9) A crew's shift schedule is said to be ***equivalent*** to another crew's shift schedule if and only if their cycles are identical; the only difference between the two crew shift schedules is the day on which their cycles begin.

10) In this research, for any crew shift schedule having *CR* crews, crew *one* will be the first crew to start a cycle, followed by crews *two* through *CR*, consecutively. The *cycle offset (CO)* is the total number days between the start of two consecutive crew's cycles, where $CO \in Z^+$.

2.2 Relationships Among Cyclical Crew Shift Schedules

The first relationship to be investigated is the minimum number of crews that are necessary to cover a predetermined set of workshifts each day.

2.2.1 The Number of Crews. Under normal operations, a crew may not work more than one shift per day. Using this as the standard, the absolute minimum number of crews to be scheduled must be equal to the number of workshifts per day. However, if the number of crews scheduled is equal to the number of workshifts each day, then each crew has no alternative but to be assigned to one workshift period everyday for the length of the schedule. Since AFSPACECOM regulations allow for each crew to have off-shift periods, another crew must be available to work when a crew is off-shift (3). Therefore, to ensure that crews receive off-shift periods, at least one more crew must be added to the absolute minimum. Thus, the minimum number of crews needed to cover all required workshift periods and allow for crew off-shift time is the number of workshifts per day plus one or

$$\textbf{\textit{Min CR}} = \textbf{\textit{WS}} + \textbf{\textit{1}}, \text{ where } \textit{Min CR} \in Z^+. \qquad (2 - 1)$$

Currently, AFSPACECOM regulations provide no limit to the maximum number of crews that may be used to construct a crew shift schedule; nevertheless, the number of crews may be limited by the number of persons assigned to the squadron's crew force coupled with

the minimum manpower requirement for each crew. Historically, Space Operations Squadrons have constructed schedules using three crews or five crews. In this research, the maximum number of crews considered is five.

2.2.2 The Number of Off-Shifts Per Day. Providing a number of crews greater than the number of workshifts per day will allow for each crew to have off-shift time. In general, the total number of crews used by a crew shift schedule is

$$\boldsymbol{CR = WS + N}, \text{ where } N \in Z^{+} \qquad (2 - 2)$$

During any 24-hour period, one crew must be assigned to each of the workshifts for that day. Any remaining crews not assigned to a workshift will have an off-shift. Therefore, the ***total number of crews having an off-shift each day in the cycle:***

$$\boldsymbol{N = CR - WS}, \text{ where } N \in Z^{+} \qquad (2 - 3)$$

Hence, "*N*" represents the number of off-shifts per day.

2.2.3 The Relationship Between the Cycle Length and Shifts. In Section 2.1, the cycle length is defined as the number of consecutive days in which a crew completes a sequence of workdays and off-days before the sequence repeats. A mathematical representation of the cycle length may be found by adding the number of workshifts and the number of off-shifts. So, for *WS* = 2 and *WS* =3, the cycle length for any crew *i* may be expressed respectively as

$$\boldsymbol{CL_i = DS_i + NS_i + OS_i}\ ; \quad i = 1, 2, \ldots, CR, \text{ and} \qquad (2 - 4)$$

$$\boldsymbol{CL_i = DS_i + SS_i + MS_i + OS_i}\ ; \quad i = 1, 2, \ldots, CR. \qquad (2 - 5)$$

A crew's shift schedule is equivalent to another crew's shift schedule if their cycles are identical. It therefore follows that when two crew schedules are equivalent, their cycle lengths are equal, meaning

$$\boldsymbol{CL_i = CL_j}\ ;\ \forall\ i, j \in \{1, 2, \ldots, CR\}. \qquad (2 - 6)$$

In addition, if crew schedules are equivalent, then the number of workshifts and off-shifts must also be the same for all crews. Thus, when $WS = 2$,

$$\boldsymbol{DS_i = DS_j\ ;\ NS_i = NS_j\ ;\ and\ OS_i = OS_j\ ;}$$
$$\forall\ i, j \in \{1, 2, \ldots, CR\}. \qquad (2 - 7)$$

Likewise, when $WS = 3$,

$$\boldsymbol{DS_i = DS_j\ ;\ SS_i = SS_j\ ;\ MS_i = MS_j\ ;\ and\ OS_i = OS_j\ ;}$$
$$\forall\ i, j \in \{1, 2, \ldots, CR\}. \qquad (2 - 8)$$

2.2.4 The Number of "Same" Workshift Periods Per Cycle.

2.2.4.1 The Total Number of Day-shifts Per Crew. When $WS = 2$, there is *one* day-shift per day each day of the cycle. Therefore, the total number of day-shifts in the cycle equals the cycle length. Since each day-shift is worked by exactly one crew, then

$$\sum_{i=1}^{CR} DS_i = CL\ . \qquad (2 - 9)$$

Since crew schedules are equivalent, $DS_1 = DS_2 = \ldots = DS_{CR-1} = DS_{CR}$. This yields the following equation

$$DS_i \times CR = CL;\ \forall\ i = 1, 2, \ldots, CR. \qquad (2 - 10)$$

Solving for DS_i, the relationship between cycle length and total number of day-shifts per crew is

$$DS_i = \frac{CL}{CR}\ ;\ \forall\ i = 1, 2, ..., CR. \qquad (2 - 11)$$

2.2.4.2 The Total Number of Same Workshift Periods Per Crew. When $WS = 2$, there is *one* night-shift per day on any day in the cycle. Using the same analysis as in Section 2.2.4.1, the total number of night-shifts per crew is

$$NS_i = \frac{CL}{CR}\ ;\ \forall\ i = 1, 2, ..., CR. \qquad (2 - 12)$$

Moreover, when WS = 3, the same relationship holds for DS_i, SS_i, and MS_i.

Hence, the relationship between cycle length and any workshift may be summarized as follows:

$$\text{Given } WS = 2:\ DS_i = \frac{CL}{CR} \text{ and } NS_i = \frac{CL}{CR}\ ;\ \forall\ i = 1, 2, ..., CR.$$

$$\text{Given } WS = 3:\ DS_i = \frac{CL}{CR}\ ,\ SS_i = \frac{CL}{CR}\ ,\ \text{and } MS_i = \frac{CL}{CR}\ ;\ \forall\ i = 1, 2, ..., CR.$$

2.2.4.3 The Relationship Among Workshifts. Using the results obtained in Section 2.2.4.2, it may be deduced that when $WS = 2$, the total number of day-shifts worked must equal the total number of night-shifts worked, $DS_i = NS_i$. Similarly, when $WS = 3$, the total number of day-shifts equals the total number of swing-shifts equals the total number of midnight-shifts, $DS_i = SS_i = MS_i$.

2.2.5 The Number of Off-shifts Per Crew. The relationship between cycle length and off-shifts differs from the relationship shown between the cycle length and workshifts. Equation (2 - 3) states there are *N* off-shifts per day on any day during the cycle (where *N* may be greater than or equal to one). Therefore, the total number of off-shifts in the cycle must be equal to *N* times the cycle length. To find the total number of off-shifts each crew has in the cycle, the same principles applied in section 2.2.4.1 are used. Hence,

$$\sum_{i=1}^{CR} OS_i = CL . \qquad (2 - 13)$$

Again using the requirement that all crew schedules are equivalent, $OS_1 = OS_2 = \ldots = OS_{CR-1} = OS_{CR}$, and it follows that

$$OS_i \times CR = CL \times N; \; i = 1, 2, \ldots, CR. \qquad (2 - 14)$$

Thus, solving for the total number of off-shifts per crew:

$$OS_i = \frac{CL \times N}{CR}; \; i = 1, 2, \ldots, CR. \qquad (2 - 15)$$

Using Equation (2 - 3), $(CR - WS)$ may be substituted for *N* in Equation (2 -15). This yields

$$OS_i = \frac{CL\,(CR - WS)}{CR} = CL\left(1 - \frac{WS}{CR}\right); \quad i = 1, 2, \ldots, CR. \qquad (2 - 16)$$

2.2.6 The Relationship Between Workshifts and Off-shifts.

2.2.6.1 The Relationship Between Day-shifts and Off-shifts. Recall that Equation (2 -10) revealed that $DS_i \times CR = CL$; $\forall\, i = 1, 2, \ldots, CR$. From Equation (2 -16), the relationship between cycle

length and off-shifts is $OS_i = \frac{CL\,(CR - WS)}{CR}$. When $CR > WS$, Equation (2 -16) may be rewritten as

$$OS_i\left(\frac{CR}{CR - WS}\right) = CL\ ;$$
$$i = 1, 2, \ldots, CR \text{ and } CR > WS. \qquad (2 - 17)$$

Thus, Equations (2 -10) and (2 -17) may be used to derive the following equation:

$$DS_i \times CR = OS_i\left(\frac{CR}{CR - WS}\right);$$
$$i = 1, 2, \ldots, CR \text{ and } CR > WS. \qquad (2 - 18)$$

Solving for DS_i, this equation becomes

$$DS_i = \frac{OS_i}{CR - WS}\ ;$$
$$\forall\ i = 1, 2, \ldots, CR \text{ and } CR > WS. \qquad (2 - 19)$$

2.2.6.2 The Relationship Between Workshifts and the Off-shift. In Section 2.2.4.2 the following relationships were established: when $WS = 2$, $DS_i = NS_i = \frac{CL}{CR}$ and when $WS = 3$, $DS_i = SS_i = MS_i = \frac{CL}{CR}$. Therefore, it follows from the analysis developed in Section 2.2.6.1 that the relationship between the number of workshifts per cycle and the number of off-shifts per cycle when $CR > WS$ may be written as

$$DS_i = NS_i = \frac{OS_i}{CR - WS}, \text{ when } WS = 2, \text{ and} \qquad (2 - 20)$$

$$DS_i = SS_i = MS_i = \frac{OS_i}{CR - WS}, \text{ when } WS = 3 \qquad (2 - 21)$$

2.2.7 The Cycle offset. In Section 2.1, a cycle is defined as a sequence of shifts that are repeated indefinitely and the cycle length (*CL*) is defined as the number of consecutive days in which a crew completes a sequence of workshifts and off-shifts before a sequence repeats. Assuming crew *one* starts its first cycle on day *"1"*, then it must complete its first cycle on day "*CL*." Crew *one* will then begin its second cycle on day "*1+CL*."

The results from Section 2.2.2 revealed that on any day in the cycle when $WS = 2$, there is *one* day-shift, *one* night-shift, and N off-shifts and when $WS = 3$, there is *one* day-shift, *one* swing-shift, *one* midnight-shift, and N off-shifts. This being the case, crew *one* may be the only crew to start its cycle on day *"1"*.

Equivalence of crew schedules is a characteristic of shift schedules used for satellite operations. In Section 2.2.3, it was established that for two crew shift schedules to be equivalent, their cycles must be identical, their cycle lengths must be equal and the total number of "same" workshift periods and off-shifts each crew has must be the same. Hence, the only difference between crew schedules is the day on which each crew begins its cycle. Therefore, each of the remaining crews, *two* through *CR*, must begin their cycles on different days between day *"1"* and day "*CL*."

The cycle offset, $CO_{k,\ k+1(\text{mod } CR)}$ is the total number of days between the start of crew *k's* cycle and crew *k+1's* cycle, where $CO \in Z^+$. When $k = CR$, the cycle offset is the number of days from the time crew *CR* starts its cycle to the day that crew *one* begins its next cycle.

For example, Crew *one* begins its first cycle on day "*1*" and completes on day "*CL*." Crew *two* will begin its first cycle "$CO_{1,2}$" days from the day crew *one* began its cycle. Thus, crew *two* will start its cycle on day "$1+CO_{1,2}$." Crew *three* will then begin its first cycle "$CO_{2,3}$" days from the day crew *two* began its cycle. This means that crew three begins its first cycle "$CO_{1,2} + CO_{2,3}$" days from day *"1"*, so crew *three* will begin its first cycle on day "$1 + CO_{1,2} + CO_{2,3}$."

Crew *one* will start its second cycle $CO_{CR,1}$ days after crew *CR* begins its first cycle. As mentioned previously, this is day "*1+CL*." Therefore,

$$1 + CO_{1,2} + CO_{2,3} + \ldots CO_{CR-1,CR} + CO_{CR,1} = 1 + CL\,. \qquad (2 - 22)$$

This means that

$$CO_{1,2} + CO_{2,3} + \ldots CO_{CR-1,CR} + CO_{CR,1} = CL, \text{ or}$$

$$\sum_{k=1}^{CR} CO_{k,\,k+1(\text{mod } CR)} = CL. \qquad (2 - 23)$$

For this research, it is assumed that the cycle offsets between two consecutive crews are equal. Letting CO represent this common offset, then

$$CR \times CO = CL. \qquad (2 - 24)$$

Solving Equation (2 - 24) for *CO* gives

$$CO = \frac{CL}{CR}\,. \qquad (2 - 25)$$

Recall from Section 2.2.4.2 that the relationship between cycle length and any workshift is $DS_i = \frac{CL}{CR}$ and $NS_i = \frac{CL}{CR}$ when $WS = 2$ and $DS_i = \frac{CL}{CR}$, $SS_i = \frac{CL}{CR}$, and $MS_i = \frac{CL}{CR}$ when $WS = 3$. Thus, when WS = 2 and WS = 3, it follows that $CO = DS_i = NS_i$ and $CO = DS_i = SS_i = MS_i$. Intuitively, this relationship makes sense because when $WS = 2$, there may only be *one* day-shift per day and *one* night-shift per day; and when $WS = 3$, there may only be *one* day-shift, *one* swing-shift, and *one* midnight-shift per day. If the shift cycle were sequenced so that all the day-shifts were consecutive, crew *two* would not be allowed to start its set of day-shifts until crew *one* completed its set of day-shifts.

Subsequently, crew *three* may not begin its set of day-shifts until crew *two* has completed its set of day-shifts and so forth. Thus, it follows that the cycle offset would equal the number of day-shifts. The same relationship also holds for the night-shift, swing-shift, and midnight-shift.

2.2.8 The Total Number of Possible Combinations of Crew Shift Schedules. Given a set of CL shifts, the total number of day-shifts per crew, DS_i, the total number of night-shifts per crew, NS_i, and the total number of off-shifts per crew, OS_i, a relevant question to ask is, how may combinations can be formed? A combination is any unordered subset of size k that can be determined from a set of n distinct objects (5:50). In the case where WS = 2, there are CL objects and there are subsets of sizes DS_i, NS_i, and OS_i. Thus, the number of ways to choose the day-shifts from the total number of days in the cycle is $\binom{CL}{DS_i}$. The number of ways to choose the night-shifts from the total number of days in the cycle given the number of day-shifts already chosen is $\binom{CL - DS_i}{NS_i}$; and since $WS = 2$, the remaining days must be off-shifts.

Therefore, the total number of possible combinations for a schedule having $WS = 2$ is

$$\binom{CL}{DS_i} \times \binom{CL - DS_i}{NS_i} = \left(\frac{CL!}{DS_i!\,(CL - DS_i)!}\right) \times \left(\frac{(CL - DS_i)!}{NS_i!\,(CL - DS_i - NS_i)!}\right) \quad (2 - 26)$$

Since $OS_i = CL - DS_i - NS_i$, then the right-hand-side of Equation (2 - 26) may be restated as

$$\frac{CL!}{DS_i!\,NS_i!\,OS_i!}\ ; \quad i = 1, 2, \ldots, CR. \quad (2 - 27)$$

Using this analysis when WS = 3, the total number of possible combinations for a schedule with cycle length *CL* is

$$\frac{CL!}{DS_i!\, SS_i!\, MS_i!\, OS_i!} \; ; \; i = 1, 2, \ldots, CR. \qquad (2 - 28)$$

By substituting the results from Sections 2.2.4 and 2.2.5, both Equations (2 - 27) and (2 - 28) may be expressed as

$$\frac{CL!}{\left[\left(\frac{CL}{CR}\right)!\right]^{WS}\left[CL\left(1 - \frac{WS}{CR}\right)\right]!} \qquad (2 - 29)$$

The process of determining the total number of possible combinations may be illustrated using the parameters from the 2/2/2/4 shift schedule. The current crew shift schedule uses three workshift periods, requires a cycle length of ten days, and requires a crewforce of five crews. Thus, substituting these values in Equation (2 - 29) results in 18,900 possible shift schedule combinations.

2.3 Chapter Summary

The mathematical relationships presented in this chapter are used in Chapter III to establish a method for constructing alternative cyclical crew shift schedules.

Chapter III

3. Generating Alternative Crew Shift Schedules

Chapter II presents the mathematical relationships inherent to the cyclical crew shift schedules used in satellite operations. This chapter begins by using the cycle offset and relevant mathematical relationships to develop a method for generating alternative crew shift schedules. This method is then modified to generate only crew shift schedules that adhere to Air Force Space Command regulations and normal space operation procedures. The modified method is demonstrated by using parameters attained from the current crew shift schedule employed by the First Space Operations Squadron. The result is a comparable alternative crew shift schedule. This chapter then suggests a way to measure the effectiveness of each schedule by introducing a set of criteria that compare alternative crew shift schedules to the schedule currently used in operations.

3.1 The Procedure for Generating a Cyclical Crew Shift Schedule

3.1.1 Create a Partial Crew Shift Schedule. In Chapter II, the cycle offset is defined as the total number of days between the start of two consecutive crew's cycles. Section 2.2.6 revealed that summing the cycle offset for each crew would result in $CO_{12} + CO_{23} + \ldots + CO_{CR-1,CR} + CO_{CR,1} = CL$. Since the cycle offset between consecutive crew shift schedules is assumed to be equal, $CR \times CO = CL$. Figure 3.1 shows a partial schedule of size "*CR* x *CO*." Note that a total of "*CL*" shifts must be assigned in this partial schedule. Each row of "*CO*" days is called a *set* and the total number of sets is equal to *CR*.

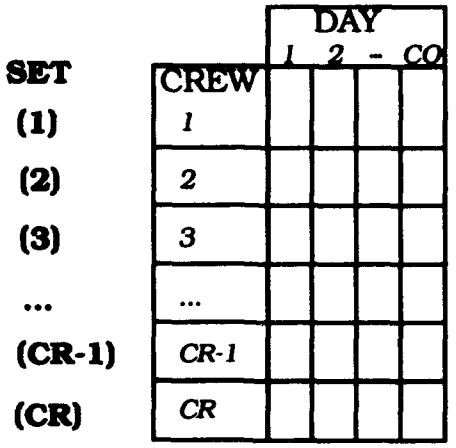

Figure 3.1: Partial Shift Schedule of Size *CR* x *CO*

The analysis conducted in Sections 2.2.4 through 2.2.5 leads to the conclusion that a partial schedule with "*CL*" shifts, must have $\frac{CL}{CR}$ day-shifts, $\frac{CL}{CR}$ swing-shifts, $\frac{CL}{CR}$ midnight-shifts, and $\frac{CL \times N}{CR}$ off-shifts when *WS* = 3. To assign these shifts to the partial schedule, recall the requirement that on any day of the schedule, there must be *one* day-shift, *one* swing-shift, *one* midnight-shift and *N* off-shifts. This being the case, then each set has a different sequence of shifts.

3.1.1.1 Create a Cycle From the Partial Schedule. By arranging the sets of the partial schedule in succession, it is possible to create a cycle. The cycle is obtained by rotating from one set to the next set in a consecutive order, as shown in Figure 3.2. For example, crew *one* begins its first cycle by following the sequence of shifts in set(1). Crew *one* then rotates to set(CR) and carries out that set's sequence of shifts. Upon completing set(CR), crew *one* rotates to set(CR-1); and so on until it rotates to its last set of shifts, set(2). When crew *one* finishes the last shift in set(2), crew *one* has completed one cycle. Crew *one* may begin its second cycle with the sequence of shifts in set(1).

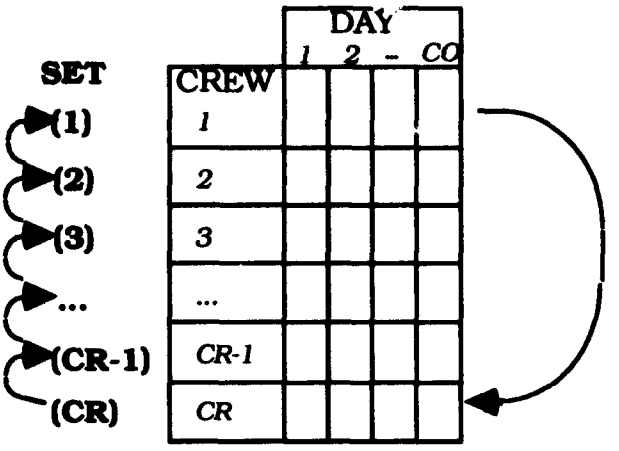

Figure 3.2: The Rotation of Sets

3.1.1.2 Generate a Crew Shift Schedule Using the Cycle. Concurrent with crew *one* beginning its cycle with set(1), the remaining crews execute their initial sequence of shifts. Each crew then rotates through each of the sets in order. The rotation order among the sets is the same for all the crews; the only difference is that each crew begins with a different set. Each crew must then continue through all the sets according to the selected rotation pattern. For this research, the rotation pattern is: set(1) ⇒ set(CR) ⇒ set(CR-1) ⇒ .... ⇒ set(3) ⇒ set(2) ⇒ set(1) ⇒ ... . Each crew moves through the sets as follows:

Crew *1*: set(1) ⇒ set(CR) ⇒ set(CR-1) ⇒ .... ⇒ set(3) ⇒ set(2) ⇒ set(1);

Crew *2*: set(2) ⇒ set(1) ⇒ set(CR) ⇒ set(CR-1) ⇒ .... ⇒ set(3) ⇒ set(2);

.

.

Crew *CR-1*: set(CR-1) ⇒ set(CR-2) ⇒ .... ⇒ set(2) ⇒ set (1) ⇒ set(CR) ⇒ set(CR-1);

Crew *CR* : set(CR) ⇒ set(CR-1) ⇒ .... ⇒ set(3) ⇒ set(2) ⇒ set(1) ⇒ set(CR).

3.1.2 Assign Shifts to the Partial Crew Shift Schedule. In Figure 3.3, the partial schedule is assigned symbols to represent its scheduled shift assignments. Assuming there is a total of z shift periods per day, then on any given day in the cycle, one shift period represented by each letter "a" through "z" must be assigned each day.

SET		DAY			
		1	*2*	-	*CO*
	CREW				
(1)	*1*	a_1	a_2	-	a_{CO}
(2)	*2*	z_1	z_2	-	z_{CO}
(3)	*3*	y_1	y_2	-	y_{CO}
...	...	-	-	-	-
(CR-1)	*CR-1*	c_1	c_2	-	c_{CO}
(CR)	*CR*	b_1	b_2	-	b_{CO}

Figure 3.3: Partial Schedule of Size *CR* x *CO* with Shift Assignments

3.1.3 Determine the Crew Shift Schedule. Applying the rotation sequence given in the previous section, each crew's shift schedule during a period of "*CL*" days is:

Crew *1*: $a_1 \Rightarrow a_2 \Rightarrow \ldots \Rightarrow a_{CO} \Rightarrow b_1 \Rightarrow b_2 \Rightarrow \ldots \Rightarrow b_{CO} \Rightarrow c_1 \Rightarrow c_2 \Rightarrow \ldots \Rightarrow c_{CO}$
$\Rightarrow \ldots\ldots \Rightarrow y_1 \Rightarrow y_2 \Rightarrow \ldots \Rightarrow y_{CO} \Rightarrow z_1 \Rightarrow z_2 \Rightarrow \ldots. \Rightarrow z_{CO}$;

Crew *2*: $z_1 \Rightarrow z_2 \Rightarrow \ldots. \Rightarrow z_{CO} \Rightarrow a_1 \Rightarrow a_2 \Rightarrow \ldots \Rightarrow a_{CO} \Rightarrow b_1 \Rightarrow b_2 \Rightarrow \ldots \Rightarrow b_{CO} \Rightarrow$
$c_1 \Rightarrow c_2 \Rightarrow \ldots \Rightarrow c_{CO} \Rightarrow \ldots\ldots \Rightarrow y_1 \Rightarrow y_2 \Rightarrow \ldots \Rightarrow y_{CO}$;

.
.

Crew *CR-1*: $c_1 \Rightarrow c_2 \Rightarrow \ldots \Rightarrow c_{CO} \Rightarrow \ldots\ldots \Rightarrow y_1 \Rightarrow y_2 \Rightarrow \ldots \Rightarrow y_{CO} \Rightarrow z_1 \Rightarrow z_2 \Rightarrow \ldots.$
$\Rightarrow z_{CO} \Rightarrow a_1 \Rightarrow a_2 \Rightarrow \ldots \Rightarrow a_{CO} \Rightarrow b_1 \Rightarrow b_2 \Rightarrow \ldots \Rightarrow b_{CO}$;

Crew *CR*: $b_1 \Rightarrow b_2 \Rightarrow \ldots \Rightarrow b_{CO} \Rightarrow c_1 \Rightarrow c_2 \Rightarrow \ldots\ldots \Rightarrow c_{CO} \Rightarrow \ldots \Rightarrow y_1 \Rightarrow y_2 \Rightarrow \ldots \Rightarrow y_{CO} \Rightarrow z_1 \Rightarrow z_2 \Rightarrow \ldots \Rightarrow z_{CO} \Rightarrow a_1 \Rightarrow a_2 \Rightarrow \ldots \Rightarrow a_{CO}.$

Figure 3.4 shows the full crew shift schedule for "*CR x CO*" days or "*CL*" days. A cyclical crew shift schedule is created by repeating this schedule indefinitely. Note that each day in the shift schedule displayed in Figure 3.4 contains one "a" shift period, one "b" shift period, one "c" shift period, and so on through one "z" shift period. Thus, this cyclical crew shift schedule fulfills each day's shift requirements.

	DAY																						
	1	2	...	CO	CO +1	CO +2	...	2 x CO	...	...	...	3 x CO	...	...	...	...	...	...	...	...	...	...	...	CR CO
CREW 1	a_1	a_2	...	a_{CO}	b_1	b_2	...	b_{CO}	c_1	c_2	...	c_{CO}	...	...	...	...	y_1	y_2	...	y_{CO}	z_1	z_2	...	z_{CO}
2	z_1	z_2	...	z_{CO}	a_1	a_2	...	a_{CO}	b_1	b_2	...	b_{CO}	c_1	c_2	...	c_{CO}	...	...	...	...	y_1	y_2	...	y_{CO}
3	y_1	y_2	...	y_{CO}	z_1	z_2	...	z_{CO}	a_1	a_2	...	a_{CO}	b_1	b_2	...	b_{CO}	c_1	c_2	...	c_{CO}	...	...	...	...
...	...	...	...	...	y_1	y_2	...	y_{CO}	z_1	z_2	...	z_{CO}	a_1	a_2	...	a_{CO}	b_1	b_2	...	b_{CO}	c_1	c_2	...	c_{CO}
CR-1	c_1	c_2	...	c_{CO}	...	...	...	...	y_1	y_2	...	y_{CO}	z_1	z_2	...	z_{CO}	a_1	a_2	...	a_{CO}	b_1	b_2	...	b_{CO}
CR	b_1	b_2	...	b_{CO}	c_1	c_2	...	c_{CO}	...	...	...	...	y_1	y_2	...	y_{CO}	z_1	z_2	...	z_{CO}	a_1	a_2	...	a_{CO}

Figure 3.4: Crew Shift Schedule

The key to constructing a crew shift schedule is to apply the mathematical relationships developed in Chapter II. To set up a partial schedule, this procedure uses a cycle offset that is equal to the cycle length divided by the number of crews. The next step in the procedure is to assign shifts so there is *one* day-shift, *one* swing-shift, *one* midnight-shift and *N* off-shifts each day, then rotate among the sets in the partial schedule according to the set rotation pattern. This procedure creates potential crew shift schedules; however, not all of the crew shift schedules generated by this method comply with the regulations and

guidelines set by Air Force Space Command and the Space Operations Squadrons. Therefore, this procedure needs a slight modification.

3.2 Generating Feasible Crew Shift Schedules

The formula to find the total number of shift schedule combinations was presented in Section 2.2.8 of Chapter II. Although it is possible to generate all possible shift schedule combinations, not all the schedule combinations are feasible. Constraints imposed by Air Force Space Command regulations make some shift schedule combinations unsuitable for operations. For a cycle to be considered feasible, it must comply with AFSPACECOM Regulation 55-16.

3.2.1 AFSPACECOM Regulation 55-16.

3.2.1.1 Consecutive Workshifts. AFSPACECOM regulations state that a crew member may not work more than one workshift period per day. When a crew serves a series of consecutive workdays, the minimum amount of time from the end of one workshift to the beginning of the next workshift must be twelve hours (3).

On the other hand, AFSPACECOM regulations do not stipulate a minimum or maximum number of consecutive days a person must work. The regulation does, however, permit commander discretion. The current standard for the maximum number of consecutive duty days for satellite crew operations is six days. Hence, this research will use six days as the maximum number of consecutive workdays and one as the minimum.

3.2.1.2 Consecutive Off-shifts. AFSPACECOM regulations do impose a constraint concerning the maximum amount of time a crew may be off-shift. The maximum amount of time allowed from the end of one working shift to the beginning of another working shift is 96 hours. The regulation also states that for every set of three consecutive workdays, a crew is authorized to receive a minimum of 24 hours of off-shift time (3). For this research, the amount of off-shift

time a crew receives is a minimum of 24 hours and a maximum is 96 hours.

3.2.2 Using AFSPACECOM Regulation 55-16 to Generate Compatible Sets. Cycles are created by ordering the sets of a partial schedule in succession. To ensure that a cycle complies with AFSPACECOM regulations, two conditions must be met. The first condition is that each set within a partial schedule must be internally compatible. For a set to be internally compatible, the shifts within the set must be sequenced so that they do not violate AFSPACECOM regulations.

The second condition for cycle feasibility is that consecutive sets must be compatible. Consecutive sets are compatible if the ordered sequence of shifts in both sets do not violate AFSPACECOM regulations.

3.2.2.1 Internal Compatibility. The compatibility of a set may be illustrated by referring to Figure 3.3. As shown in the figure, the sequence for set(1) is $a_1 \Rightarrow a_2 \Rightarrow ... \Rightarrow a_{co}$. For set(1) to be internally compatible, the shift represented by "a_2" must be compatible with shift "a_1." Subsequently, "a_3" must be compatible with "a_2;" then "a_4" with "a_3;" and so on, continuing to shift "a_{co}." The final shift in the set, a_{co}, must be compatible with shift a_{co-1}.

When WS = 3, there are three workshifts per day; the day-shift (D), the swing-shift (S) and the midnight-shift (M). Routine operations for SOPS dictate that the first workshift of the day is the day-shift, the second workshift of the day is the swing-shift, and the third workshift of the day is the midnight-shift. Let the workshift combination, D $\Rightarrow$ M, occur within set(1)'s sequence. This would mean a crew would work the day-shift on one of the days in the sequence and then work the midnight-shift on the following day. The combination of changing from a day-shift to a midnight-shift is permissible under AFSPACECOM regulations; and therefore, the combination D $\Rightarrow$ M is allowable.

However, if the workshift combination was M ⇒ D, then a crew would be required to work the day-shift immediately following the midnight-shift. This shift combination would result in a crew working two workshifts in succession which is not allowed by AFSPACECOM regulations (3). Therefore, the combination M ⇒ D is not allowable.

3.2.2.2 Compatibility Between Sets. As stated in Section 3.1.3, all crews follow the same basic rotation pattern: set(1) ⇒ set(CR) ⇒ set(CR-1) ⇒ ... ⇒ set(3) ⇒ set(2) ⇒ set(1) ⇒ ... . To illustrate the compatibility between sets, again refer to Figure 3.3. For the two consecutive sets, set(1) and set(CR), to be compatible, day "*CO*" of set(1) must be compatible with day "*1*" of set(CR). In other words, the shift represented by "a_{co}" must be compatible with shift "b_1." The process, comparing the last day of each set to the first day of its succeeding set, will continue until all the sets have been checked.

3.3 Generating A Comparable Alternate Crew Shift Schedule

The current crew shift schedule used by the First Space Operations Squadron is the 2/2/2/4 shift schedule shown in Figure 3.5. This schedule replaced the original 6/4 schedule.[1] The 6/4 schedule required each crew to stay on the same shift for six consecutive work-shifts and then have four off-shifts before changing to the next workshift. The major problem with the 6/4 schedule is that it violates the 96-hour maximum off-duty period allowed by AFSPACECOM Regulation 55-16 (3). The 2/2/2/4 shift schedule employs five crews following a cycle consisting of six days of duty followed by four days of non-duty. The crews proceed through their six duty days in the following manner: two day-shifts, two swing-shifts, two midnight-shifts, and four off-shifts. Crew personnel object to this schedule because the number of workshift changes during the period of consecutive duty days (1). Specifically, crews must make two workshift changes in a period of six days.

---

[1] Refer to Figure 1.2.

This part of the research seeks an answer to the question: *Is there another crew shift schedule that maintains three workshifts and five crews, maximizes the total amount of off-shift time, and reduces the number of workshift changes during any consecutive period of work days ?* --- If there is such a schedule, *is this alternative crew shift schedule better than the current 2/2/2/4 shift schedule?*

	DAYS IN SCHEDULE																														
CREW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
A	D	D	S	S	M	M					D	D	S	S	M	M					D	D	S	S	M	M					D
B			D	D	S	S	M	M					D	D	S	S	M	M					D	D	S	S	M	M			
C					D	D	S	S	M	M					D	D	S	S	M	M					D	D	S	S	M	M	
D	M	M					D	D	S	S	M	M					D	D	S	S	M	M					D	D	S	S	M
E	S	S	M	M					D	D	S	S	M	M					D	D	S	S	M	M					D	D	S

Figure 3.5: The 2/2/2/4 Shift Schedule

3.3.1 The Characteristics of Alternative Schedules.

3.3.1.1 The Schedule Objectives and Attributes. The process of generating a shift schedule begins by establishing the objectives and attributes of the schedule. For this research, the objectives of the schedule are to:

1) Maximize the total number of consecutive off-shifts allowed; and

2) Minimize the number of workshift changes among consecutive duty days.

The attributes that the schedule must have are:

1) Three workshifts per day, $WS = 3$; and

2) Five crews, $CR = 5$.

Accomplishing the first schedule objective calls for knowing which combination of shifts maximize the permitted continual off-shift time. Table 3.1 lists combinations of shift sequences that may occur during a cycle when constructing a shift schedule that uses three workshifts. (D: day-shift, S: swing-shift, M: midnight-shift, and O: off-shift). Table 3.1 also denotes if a sequence of shifts complies with the requirements directed by Air Force Space Command.

The options presented in Table 3.1 suggest that selecting one or more of the following shift combinations, D ⇒ O ⇒ O ⇒ O ⇒ S; S ⇒ O⇒ O ⇒ O ⇒ M; and M ⇒ O ⇒ O ⇒ O ⇒ O ⇒ D, will provide a basis for constructing a potential crew shift schedule. Each of these sequences results in 96 hours of off-shift time. Note that the current 2/2/2/4 shift schedule uses one of the three shift combinations, M ⇒ O ⇒ O ⇒ O ⇒ O ⇒ D. In this research, the alternative crew shift schedule will be generated by incorporating all three shift combinations into the schedule.

3.3.1.2 The Total Number of Off-shifts. To determine the total number of off-shift periods needed for the schedule, count the number of off-shifts in each of three shift patterns, D ⇒ O ⇒ O ⇒ O ⇒ S; S ⇒ O⇒ O ⇒ O ⇒ M; and M ⇒ O ⇒ O ⇒ O ⇒ O ⇒ D. The minimum number of off-shift days needed to generate the cycle which uses all three shift combinations is ten, $OS_i = 10$.

3.3.1.3 Off-shifts Per Day. Given $WS = 3$ and $CR = 5$ and using Equation (2-3), the total number of off-shifts per day is two, so $N = 2$.

3.3.1.4 The Cycle Length. The cycle length may be found by applying Equation (2-16) with $OS_i = 10$, $WS = 3$ and $CR = 5$. The cycle length is twenty-five days, $CL = 25$.

Table 3.1: Potential Shift Combinations Within a Schedule for Three Workshifts

Shift Sequence	Hours between workshifts	Allowed by regulations	Shift Sequence	Hours between workshifts	Allowed by regulations
DID	16	yes	SIOIOIM	72	yes
DIS	24	yes	MIOIOID	48	yes
DIM	32	yes	MIOIOIS	56	yes
SID	8	no	MIOIOIM	64	yes
SIS	16	yes	DIOIOIOID	88	yes
SIM	24	yes	DIOIOIOIS	96	yes
MID	0	no	DIOIOIOIM	104	no
MIS	8	no	SIOIOIOID	80	yes
MIM	16	yes	SIOIOIOIS	88	yes
DIOID	40	yes	SIOIOIOIM	96	yes
DIOIS	48	yes	MIOIOIOID	72	yes
DIOIM	56	yes	MIOIOIOIS	80	yes
SIOID	32	yes	MIOIOIOIM	88	yes
SIOIS	40	yes	DIOIOIOIOID	112	no
SIOIM	48	yes	DIOIOIOIOIS	120	no
MIOID	24	yes	DIOIOIOIOIM	128	no
MIOIS	32	yes	SIOIOIOIOID	104	no
MIOIM	40	yes	SIOIOIOIOIS	112	no
DIOIOID	64	yes	SIOIOIOIOIM	120	no
DIOIOIS	72	yes	MIOIOIOIOID	96	yes
DIOIOIM	80	yes	MIOIOIOIOIS	104	no
SIOIOID	56	yes	MIOIOIOIOIM	112	no
SIOIOIS	64	yes			

3.3.1.5 The Total Number of Day-shifts, Night-shifts, and Midnight-shifts. The analysis conducted in Chapter II showed that when $WS = 3$, $DS_i = SS_i = MS_i = \frac{CL}{CR}$ for $i = 1,..., CR$. Thus, in a 25-day cycle the total number of day-shifts per crew is five; the total number of night-shifts per crew is five; and the total number of midnight-shifts per crew is five.

3.3.1.6 The Cycle Offset. In Section 2.2.7, Equation (2-25) defined the cycle offset between each crew as the cycle length divided by the number of crews. Thus, the cycle offset, *CO*, is five.

3.3.2 Building a Partial Schedule. Using a cycle offset of five, begin the process of generating a crew schedule by laying out a partial schedule for five days as shown in Figure 3.6. As stated in Section 3.1.3, the rotation pattern to create a cycle is set(1) ⇒ set(5) ⇒ set(4) ⇒ set(3) ⇒ set(2) ⇒ set(1) ⇒ ... . For example, this means that crew *one* will rotate from shift set(1) to sets (5), (4), (3), and (2), respectively, and then repeat the cycle starting with set(1). The partial schedule must have five day-shifts, five swing-shifts, five midnight-shifts and ten off-shifts. The off-shift days must be grouped into sets of consecutive days to maximize the total off-shift period. Thus, the shift combinations D ⇒ O ⇒ O ⇒ O ⇒ S; S ⇒ O⇒ O ⇒ O ⇒ M ; and M ⇒ O ⇒ O ⇒ O ⇒ O ⇒ D must be included.

		DAY				
		1	2	3	4	5
	CREW					
(1)	1					
(2)	2					
(3)	3					
(4)	4					
(5)	5					

Figure 3.6: Partial Schedule Based on a Five-Day Offset

3.3.2.1 Assign Shifts to Set (1). Set(1) may be assigned any combination of compatible shifts. Since two of the three shift combinations that provide 96 hours of continual off-shift time contain five days, then let set(1) be one of these two off-shift sequences. Figure 3.7 shows set(1)'s shift sequence set to D ⇒ O ⇒ O ⇒ O ⇒ S.

		DAY				
		1	2	3	4	5
	CREW					
(1)	1	D	O	O	O	S
(2)	2					
(3)	3					
(4)	4					
(5)	5					

Figure 3.7: Set(1) Shift Combination D ⇒ O ⇒ O ⇒ O ⇒ S

3.3.2.2 Sets Compatible With Set(1). Given the set rotation pattern established in Section 3.3.2, there are two sets that must be compatible with set(1), they are set(5) and set(2). Set(1)'s shift combination leaves four day-shifts, four swing-shifts, five midnight-shifts and seven off-shifts remaining to be assigned. Recall that on any day of the schedule there is *1* day-shift, *1* swing-shift, *1* midnight-shift and *N* off-shifts. From Section 3.3.1.3, $N = 2$, so, there are two off-shifts each day. Since day *one* of set(1) is assigned a day-shift, then day *one*'s shift assignments for the remaining sets, (2) through (5), must be one swing-shift, one midnight shift, and two off-shifts. Following the established set rotation pattern, set(5) must follow set(1). Thus, the shift that is assigned on day *one* of set(5) must be compatible with the shift already assigned to day *five* of set(1). Referring to Table 3.1, a swing-shift, a midnight-shift, or an off-shift is an acceptable selection for day *one* of set(5). If an off-shift were assigned, it would be necessary to continue to assign off-shifts for two more days to maximize the

continual off-shift time. This is a reasonable option to consider; however, upon further examination, assigning an off-shift would cause a longer stretch of workdays to be assigned at a later point in the schedule. Specifically, by assigning the three off-shifts, thirteen workshifts and four off-shifts would remain. The other options are to assign either a swing- shift or a midnight-shift. Since day five of set(1) is already a swing shift and one of the objectives is to minimize the number of rotations amongst consecutive workshifts, then assign day *one* of set(5) a swing-shift.

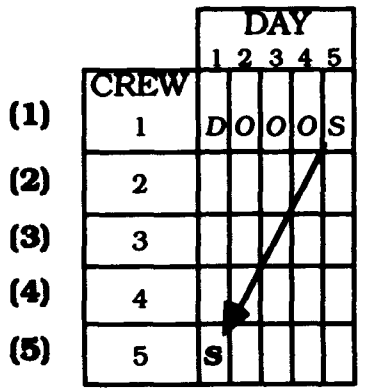

Figure 3.8: Set(5) Compatibility with Set (1)

When day *five* of set(2) is complete, the cycle repeats itself starting with set(1). Therefore, the shift chosen for day *five* of set(2) must be compatible with the shift assigned on day *one* of set(1). According to Table 3.1, the only shifts able to precede a day-shift are another day-shift or an off-shift. If an off-shift is chosen the result will be to assign off-shifts to the three days prior. The resulting shift sequence from assigning these three days as off-shifts would be four off-shifts, a day-shift, followed by three more off-shifts. This would require longer stretches of workdays in other parts of the schedule. Therefore, assign day *five* of set(2) a day-shift.

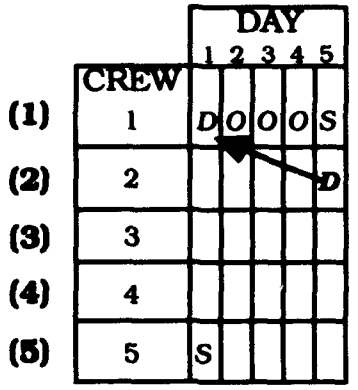

Figure 3.9: Set (1) Compatibility with Set (2)

3.3.2.3 Assign Remaining Shifts to Set(5). Referring again to set(5), day *five* may not be a swing-shift, because set(1) is already assigned a swing-shift on day five; nor can it be a day-shift because day *five* of set(2) is assigned the day-shift. Therefore, day *five* of set(5) must either be a midnight-shift or an off-shift. Days *two* through *four* of set(5) may be assigned swing-shifts, midnight-shifts or off-shifts. To avoid changing workshifts, continue to assign the swing-shifts from day *two* through day *four*. Note that Figure 3.10 shows five swing-shifts, and as such, all the swing-shifts required for the partial schedule are assigned.

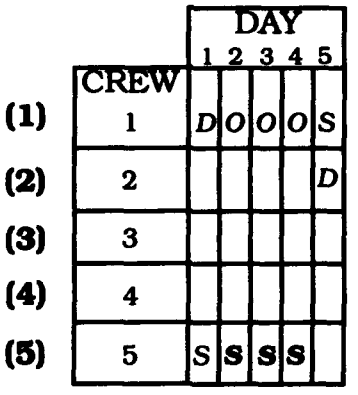

Figure 3.10: Assigning the Remaining Swing-shifts

3.3.2.4 Set Compatibility With Set(5). Set(4) follows set(5). Under the definition of compatibility, day *one* of set(4) must be compatible with day *five* of set(5). Since a day-shift and swing-shift have already been assigned to day *one*, day *one* of set(4) may either be a midnight-shift or an off-shift. Since day four of set(5) was assigned the last swing-shift of the cycle, assign the continual off-shift pattern: S ⇒ O⇒ O ⇒ O ⇒ M. Thus, Figure 3.11 shows day *five* of set(5) assigned an off-shift; day *one* and day *two* of set(4) assigned off-shifts; and day *three* assigned a midnight-shift.

		DAY				
		1	2	3	4	5
	CREW					
(1)	1	D	O	O	O	S
(2)	2					D
(3)	3					
(4)	4	O	O	M		
(5)	5	S	S	S	S	O

Figure 3.11: Shift Combination S ⇒ O⇒ O ⇒ O ⇒ M

3.3.2.5 Compatibility Within Set(4). Four off-shifts, four midnight-shifts, and three day-shifts must still be assigned. Only a midnight-shift or an off-shift may follow a midnight-shift. If the off-shift is assigned, then the shift combination of four consecutive off-shifts must be assigned, M ⇒ O ⇒ O ⇒ O ⇒ O ⇒ D. Assigning this combination would force the combination, M ⇒ D to occur at a later point in the schedule. Table 3.1 shows that a midnight-shift to a day-shift combination is not allowed. Therefore, the midnight-shift must be assigned to days *four* and *five* of set(4). The remaining two midnight-shifts must also be assigned to the first two days of set(3). Figure 3.12 shows the assignment of the remaining midnight-shifts.

		DAY				
	CREW	1	2	3	4	5
(1)	1	D	O	O	O	S
(2)	2					D
(3)	3	M	M			
(4)	4	O	O	M	M	M
(5)	5	S	S	S	S	O

Figure 3.12: Assigning the Remaining Midnight-shifts

Recall the requirement that on any given day of this partial schedule there must be one day-shift, one swing-shift, one midnight-shift, and two off-shifts. Note that on day *one* and day *five* of this partial schedule, a day-shift, swing-shift, and a midnight-shift have been assigned, thus, day *one* of set(2) and day *five* of set(3) must be assigned off-shifts. On day *two* of the partial schedule, a swing-shift, a midnight shift, and two off-shifts have been assigned. Therefore, a day-shift must be assigned to day two of set(2).

		DAY				
	CREW	1	2	3	4	5
(1)	1	D	O	O	O	S
(2)	2	O	D			D
(3)	3	M	M			O
(4)	4	O	O	M	M	M
(5)	5	S	S	S	S	O

Figure 3.13: Assigning Shifts to Meet Daily Requirements

3.3.2.6 Compatibility of Set(3). Since a day-shift cannot follow a midnight shift, the only choice for day *three* of set(3) is the off-shift. Moreover, since off duty time is to be maximized, continue to assign the off-shifts to complete the last of the three off-shift period combinations, M ⇒ O ⇒ O ⇒ O ⇒ O ⇒ D

		DAY				
	CREW	1	2	3	4	5
(1)	1	D	O	O	O	S
(2)	2	O	D			D
(3)	3	M	M	O	O	O
(4)	4	O	O	M	M	M
(5)	5	S	S	S	S	O

Figure 3.14: Shift Combination M ⇒ O ⇒ O ⇒ O ⇒ O ⇒ D

3.3.2.7 Compatibility of Set(2). The only shifts remaining to be assigned are the day-shifts. Thus, days *three* and *four* of set(2) must be assigned day-shifts to complete the partial schedule. Figure 3.15 shows the complete partial schedule of size *CR* x *CO*.

		DAY				
	CREW	1	2	3	4	5
(1)	1	D	O	O	O	S
(2)	2	O	D	D	D	D
(3)	3	M	M	O	O	O
(4)	4	O	O	M	M	M
(5)	5	S	S	S	S	O

Figure 3.15: Assigning the Remaining Day-shifts

3.3.2.8 Review the Feasibility of the Partial Schedule. The partial schedule is reexamined to ensure that it meets the standards established by Air Force Space Command regulations. For the schedule to be feasible, the following conditions must be satisfied.

1) On any day, there must be only one day-shift.

2) On any day, there must be only one swing-shift.

3) On any day, there must be only one midnight-shift.

4) On any day, there must be *N* off-shifts per day. (For this schedule, *N* must equal two off-shifts per day).

5) Each set must be internal compatible.

6) Consecutive sets must be compatible.

Note that Figure 3-15 meets all these requirements.

3.3.2.9 Schedule Objectives. Along with schedule feasibility, the schedule must be checked to see that it meets the two objectives for crew shift schedules:

1) Maximize the total number of consecutive off-shifts allowed. The three shift combinations D ⇒ O ⇒ O ⇒ O ⇒ S; S ⇒ O⇒ O ⇒ O ⇒ M; and M ⇒ O ⇒ O ⇒ O ⇒ O ⇒ D were included in the schedule; each shift combination results in 96 hours of off-shift time.

2) Minimize the number of workshift changes among consecutive duty days. The workshifts assigned during any set of consecutive duty days are the same, thereby eliminating workshift changes.

3.3.3 The Resulting Crew Shift Schedule. Using the rotation patterns in Section 3.3.2 and the partial schedule in Figure 3.15, an alternate one-month schedule is shown in Figure 3.16.

	DAYS IN SCHEDULE																														
CREW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
A	D	O	O	O	S	S	S	S	S	O	O	O	M	M	M	M	M	O	O	O	O	D	D	D	D	D	O	O	O	S	S
B	O	D	D	D	D	D	O	O	O	S	S	S	S	S	O	O	O	M	M	M	M	M	O	O	O	O	D	D	D	D	D
C	M	M	O	O	O	O	D	D	D	D	D	O	O	O	S	S	S	S	S	O	O	O	M	M	M	M	M	O	O	O	O
D	O	O	M	M	M	M	M	O	O	O	O	D	D	D	D	D	D	O	O	O	S	S	S	S	S	O	O	O	M	M	M
E	S	S	S	S	O	O	O	M	M	M	M	M	O	O	O	O	D	D	D	D	D	O	O	O	S	S	S	S	S	O	O

Figure 3.16 : The Proposed Schedule

3.4 Comparing the Alternate Schedule to the Current Schedule

To make Figure 3.16 easier to read, the off-shifts, represented by the symbol "O," were removed. Figure 3.17 illustrates the same crew shift schedule as Figure 3.16. The only difference is that a day having no entry represents a crew with an off-shift on that day.

	DAYS IN SCHEDULE																														
CREW	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
A	D				S	S	S	S	S				M	M	M	M	M					D	D	D	D	D				S	S
B		D	D	D	D	D				S	S	S	S	S				M	M	M	M	M					D	D	D	D	D
C	M	M					D	D	D	D	D				S	S	S	S	S				M	M	M	M	M				
D			M	M	M	M	M					D	D	D	D	D				S	S	S	S	S				M	M	M	M
E	S	S	S	S				M	M	M	M	M					D	D	D	D	D				S	S	S	S	S		

Figure 3.17: The 5/3- 5/3- 5/4 Shift Schedule

3.4.1 Establish Criteria to Compare Crew Shift Schedules.

Currently, Air Force Space Command and the Space Operations Squadrons do not have any formal way to measure the effectiveness of crew shift schedules. An effective schedule is one that meets specific criteria which makes it more appealing than another schedule. This

section of the research presents a list of criteria which may be used to compare two crew shift schedules.

1) First, an effective schedule must provide coverage for satellite operations 24 hours-a-day, 7-days-a-week.

2) An effective schedule would use the smallest number of people to meet the daily coverage requirements.

3) One of the major problems with previously used crew shift schedules is compliance to AFSPACECOM regulations and space operation policy. Therefore, an effective schedule complies with applicable AFSPACECOM regulations and takes advantage of any existing waivers.

4) Another area of concern is the number of workshift changes among consecutive duty days. An effective schedule minimizes the number of changes among contiguous workshifts.

5) Crew members are interested in having their off-shift time arranged so that the off-shift days are consecutive. Therefore, an effective schedule maximizes the number of continual off-shifts up to the amount of time allowed by regulations.

Ideally, all of the criteria listed should be met for a schedule to be considered effective; however, in practical operations, trade-offs among the criteria may be necessary to meet the goals and priorities of Air Force Space Command and Space Operations Squadrons. Therefore, the choice of selecting a crew shift schedule should be made by picking the schedule that best meets the criteria.

3.4.2 The Proposed Alternative Schedule Versus the Current Crew Shift Schedule. The criteria established for measuring the effectiveness of a crew shift schedule is used to compare the proposed alternate crew shift schedule to the current crew shift schedule. This section examines the elements of coverage, workforce size, compliance, workshift changes, and off-shift periods.

1) In terms of coverage, each crew shift schedule meets the standard equally.

2) Both crew shift schedules use five crews, so the size of the workforce each schedule requires is the same.

3) Both of the crew shift schedules meet the requirements directed by AFSPACECOM regulations.

4) The current 2/2/2/4 crew shift schedule requires a crew to change workshifts twice within a period of six days while the alternate schedule has zero workshift changes in its consecutive work periods of five days. Therefore, the alternate crew schedule is more effective under this measure.

5) Both schedules give crews 96 hours of off-shift time between stretches of duty days. Hence, the schedules are considered equal under this measure.

Both crew shift schedules score essentially the same in all areas except in the category of minimizing the number of workshift changes. The alternate schedule provides all the qualities of the current schedule plus the added bonus of reducing the number of workshift changes during consecutive duty days. The alternate schedule reduced the number of changes among consecutive duty days from two to zero.

In addition, the 2/2/2/4 schedule requires crew members to work six shifts to receive their 96 hours of off-shift time. The alternate

schedule only requires crew members to work five shifts to receive 96 hours off.

3.5 Chapter Summary

The relationships established between the elements of cycle length, number of workshifts, total number of crews, number of same shift periods, and cycle offset can be used to determine alternative cyclical crew shift schedules. The cycle offset, used in conjunction with other mathematical relationships, provides a method to generate alternative crew shift schedules. These crew shift schedules must adhere to Air Force Space Command regulations and normal space operation procedures. Using parameters from the current 2/2/2/4 crew shift schedule, the method to generate feasible crew shift schedules was applied. The resulting alternate crew shift schedule was compared to the 2/2/2/4 crew shift schedule using a set of criteria as a way to measure the effectiveness of each schedule. The alternate crew shift schedule was deemed more effective.

Chapter IV

4. An Approach to Non-Crew Scheduling

The First Space Operations Squadron currently assigns each of its satellite-support personnel to one of five crews and then creates a cyclical crew shift schedule. Civilian professions that require 24-hour operations, such as nursing, schedule their personnel according to individual skill level and the needs of each shift period (13:411). The suggestion of individually scheduling SOPS personnel invites an immediate negative response from the 1SOPS operations staff. The compelling argument presented by the operations staff is that crews are necessary to keep each person on the same cycle as his/her supervising official. Thus, the supervising officials are able to evaluate their subordinates much more effectively (12).

Chapter V explores this unconventional approach for scheduling SOPS personnel. Instead of assigning each person to a crew, each person is assigned to his/her own shift schedule. The objective is to examine how individually scheduling satellite personnel effects the size of the crewforce. Each person's schedule is made up of a cycle of workshifts and off-shifts. The assigned individual schedules must satisfy the daily minimum manning requirements for satellite support operations. This type of personnel scheduling problem may be modeled through a class of integer programming problems called *set covering problems*.

This chapter introduces the set covering problem by defining applicable terms, displaying a standard model, giving an example of an application, and discussing its limitations. Then, by applying the procedures from cyclical crew shift scheduling, a small test model is formulated as a set covering problem. This test model is entered into a software program [GAMS (General Algebraic Modeling System)] and solved. The purpose behind this test model is twofold: 1) to show how

to formulate a personnel scheduling problem as a set covering problem; and 2) to illustrate how to interpret the results. The primary focus of this chapter is to develop a foundation for the research and results presented in Chapter V.

4.1 Set Covering Problems

4.1.1 Terminology. An important term that must be understood about the set covering problems is the word "cover". In a set covering problem, a subset of a given set of possible solutions is chosen to exactly satisfy or exceed a set of minimum requirements. For example, let the requirement set be the need for one red, one blue, and one white ball. The given solution set contains four elements. Element A is composed of one red ball, element B contains one white ball, element C contains one blue ball, and element D contains one red and one white ball. One solution to the problem would be to use element C and element D. The result of using both elements yields one red, one blue, and one white ball. Thus, the requirement set is covered by elements C and D.

Garfinkel and Nehauser define the set covering problem as follows (8:298-300):

> 1) Given a set $I = \{1,..., m\}$ and a set $S = \{S_1,..., S_n\}$, where $S_j \subseteq I$ and $j \in J = \{1,...,n\}$, then a subset $J^* \subseteq J$ defines a ***cover*** of I if $\bigcup_{j \in J^*} S_j = I$.
>
> 2) Let $c_j > 0$ be associated with every $j \in J$. Then the total cost of the cover J^* is $\sum_{j \in J^*} c_j$.

Each element of the given set I must be "covered" by an element of set S. The objective of the set covering problem is to find a cover that minimizes cost. If the objective is to minimize the number of elements from set S that are used, then all of the cost coefficients, c_j, are equal and $c_j = 1$, $\forall j \in J$ (14:184).

4.1.2 The Set Covering Model. The set covering problem is modeled as an integer program. The mathematical representation of the set covering problem is

$$\text{Minimize } \sum_{j=1}^{n} c_j x_j$$

$$\text{Subject to } \sum_{j=1}^{n} a_{ij} x_j \geq 1, \qquad i = 1,2,\ldots, m;$$

$$x_j = 0 \text{ or } 1, \qquad j = 1,2,\ldots, n;$$

Where:

$$x_j = \begin{cases} 1, \text{ if } j \text{ is in the cover,} \\ 0, \text{ otherwise;} \end{cases} \qquad j = 1,2,\ldots, n;$$

$$a_{ij} = \begin{cases} 1, \text{if } i \in S_j, \\ 0, \text{otherwise;} \end{cases} \qquad j = 1,2,\ldots, n;$$

$$c_j > 0 \qquad j = 1,2,\ldots, n;$$

Note that any solution satisfying the constraints is called a ***cover solution***.

4.1.3 A Current Application of the Model. A principle user of the set covering model are airline companies. One personnel scheduling application is known as "the aircrew scheduling problem."

Each day major airline companies schedule thousands of flights out of cities all over the world. Typically, an airline crew may fly several of these scheduled flights on any single day. Therefore, the problem is to assign airline crews to cover the flights already scheduled. A common objective for aircrew scheduling is to minimize the total cost to the airline. Each flight combination has an associated cost, represented by

c_j in the model. Costs may include such items as per diem rates for meals and hotels. Airlines want to meet their coverage requirements at the lowest possible cost. If, instead, an airline seeks to cover all its flights during a given period using the minimum number of aircrews, then all cost coefficients equal one.

Using the notation presented in Section 4.1.1, the elements of set I are the flights which an airline must cover. The elements of set S contain possible flight combinations for aircrew members. The flight combinations are found by listing combinations of flights that physically connect and comply with airline flight crew regulations. Using the general model in Section 4.1.2, the aircrew scheduling problem may be mathematically modeled:

$$\text{Minimize} \quad \sum_{j=1}^{n} c_j x_j$$

$$\text{Subject to} \quad \sum_{j=1}^{n} a_{ij} x_j \geq 1, \qquad i = 1,2,\ldots, m;$$

$$x_j = 0 \text{ or } 1, \quad j = 1,2,\ldots, n;$$

Where:

$i \equiv$ a flight between two cities;

$j \equiv$ a particular combination of flights;

$m \equiv$ the total number of flights;

$n \equiv$ the total number of possible flight combinations;

$$x_j = \begin{cases} 1, \text{ if flight combination } j \text{ is assigned,} \\ 0, \text{ otherwise;} \end{cases}$$

$$a_{ij} = \begin{cases} 1, \text{if flight } i \text{ appears in flight combination } j, \\ 0, \text{otherwise;} \end{cases}$$

$$c_j > 0.$$

4.1.4 Drawbacks to Using Set Covering. The difficulty in set covering problems does not arise from the structure of the problem but, rather, from the number of integer variables. In practice, most set covering problems have comparatively few constraints, but an enormous number of discrete variables. A problem of this type may have a bounded feasible region with a finite number of feasible solutions; however, the set of feasible solutions may be quite large. For example, a binary integer programming problem allows the value of its discrete variables to be either one or zero. As such, a problem containing n discrete variables may have up to 2^n feasible solutions. A problem with only 25 discrete variables would yield a total of 33,554,432 possible solutions.

Problems of this type become difficult to solve because of the large number of iterations and huge amount of resource time required to find the answer to the problem. Problems that are large must be divided into several smaller problems, or the problem's size may be decreased by eliminating some of the potential cover solutions. This reduction in the set of possible solutions may reduce the computational time; however, it is important to note that eliminating a potential solution may also result in a problem in which the solution is not optimal for the original problem (10:464).

4.2 Modeling Satellite Operations as a Set Covering Problem

This section introduces a small personnel scheduling problem for satellite operations. The example problem is formulated as a set covering problem, formatted for GAMS, entered into the VAX/VMS computer system and solved. The resulting output is provided in Appendix A. An

assumption made in using the set covering model is that every person follows a cyclic schedule for a specific cycle.

4.2.1 An Example Personnel Scheduling Problem.

4.2.1.1 The Parameters. For this example, there are two workshifts each day: the day-shift and the night-shift. When $WS = 2$, the day-shift is the first shift and the night-shift is the second shift of the duty day. Assume the cycle length is four days ($CL = 4$), the cycle is composed of one day-shift ($DS = 1$), one night-shift ($NS = 1$), and two off-shifts ($OS = 2$). Recall in Section 2.2.7 that the cycle offset was assumed to be equal between successive crew cycles and that $CO = DS = NS$. Therefore, $CO = 1$. This cycle offset is used to set up the partial shift schedule that will be used to generate the set of possible schedules.

4.2.1.2 Total Number of Possible Combinations of Crew Shift Schedules. Using Equation 2.27 in Section 2.2.8, $\frac{CL!}{DS!\ NS!\ OS!}$, the total number of possible combinations for a schedule that this four-day cycle may have is twelve. However, as Section 3.2 explained, not all twelve shift combinations are feasible. Table 4.1 shows the shift combinations that occur when constructing a shift schedule specifically for managing one day-shift (D), one swing-shift (S), and two off-shifts (O). The table also indicates if a shift combination is feasible under the requirements directed by Air Force Space Command.

Table 4.1 Shift Combinations for the Four-day Cycle

Shift Sequence	Hours Between Shifts	Allowed by regulations
DIN	24	yes
NID	0	no
DIOIN	48	yes
NIOID	24	yes
DIOIOIN	72	yes
NIOIOID	48	yes

4.2.1.3 Using the Cycle Offset to Generate Potential Shift Schedules. Part one of Chapter III introduced a procedure to generate alternative crew shift schedules. The same principles used to generate the crew shift schedules may be applied here to generate all possible combinations of schedules with a cycle length equal to four. Given $CO = 1$, Figure 4.1 shows the partial schedule that is used to generate cycles.

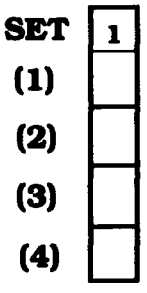

Figure 4.1 Partial Schedule of Size 4 x 1

The rotation pattern for this partial schedule is: set(1) ⇒ set(4) ⇒ set(3) ⇒ set(2) ⇒ set(1) ⇒ ... . Thus, allowing set(1) to begin with the day-shift creates the partial schedules illustrated in Figures 4.2, 4.3 and 4.4:

	DAY
SET	1
(1)	D
(2)	N
(3)	O
(4)	O

Figure 4.2 Partial Schedule #1

	DAY
SET	1
(1)	D
(2)	O
(3)	N
(4)	O

Figure 4.3 Partial Schedule #2

	DAY
SET	1
(1)	D
(2)	O
(3)	O
(4)	N

Figure 4.4 Partial Schedule #3

4.2.1.4 Cycle Feasibility. Before proceeding, the feasibility of each partial schedule must be determined. Referring to Section 3.2, the partial schedule is feasible if each set is internally compatible; and all sets are compatible with each other. The internal compatibility is automatic since there is only one day in each set. The compatibility between each set may be verified by confirming compatibility of set(1) with set(4); set(4) with set(3); set(3) with set(2); and finally set(2) with set(1). From Table 4.1, the only shift combination not allowed by AFSPACECOM regulations is $N \Rightarrow D$. Thus, partial schedule #1 is not feasible and any cycle generated from this partial schedule is not a feasible schedule.

Using the rotation patterns defined in Section 4.2.1.3, partial schedule #2 and partial schedule #3 yield the following shift combinations:

1) D ⇒ O ⇒ N ⇒ O;
2) O ⇒ N ⇒ O ⇒ D;
3) N ⇒ O ⇒ D ⇒ O;
4) O ⇒ D ⇒ O ⇒ N;
5) D ⇒ N ⇒ O ⇒ O;
6) N ⇒ O ⇒ O ⇒ D;
7) O ⇒ O ⇒ D ⇒ N; and
8) O ⇒ D ⇒ N ⇒ O;

These eight shift combinations make up the elements contained in the set of schedules.

4.3 Formulating the Set Covering Problem

For this example, the manning requirement is for at least one person to be assigned to each workshift in the cycle. There are four days in the cycle and two workshifts per day; therefore, there are a total of eight workshifts per cycle. Only one person may be assigned to each cycle that is selected. The objective is to minimize the number of people needed to cover the eight workshift periods. Since the goal is to

minimize the size of the workforce, all cost coefficients, cj, equal one. Thus, the example problem is formulated as follows:

$$\text{Minimize} \quad \sum_{j=1}^{n} x_j$$

$$\text{Subject to} \quad \sum_{j=1}^{n} a_{ij} x_j \geq 1, \qquad i = 1,2,\ldots, m;$$

$$x_j = 0 \text{ or } 1, \qquad j = 1,2,\ldots, n;$$

Where:

$i \equiv$ a particular workshift in the cycle;

$j \equiv$ a specific shift combination;

m $\equiv$ the total number of workshifts in the cycle; m=8;

n $\equiv$ the total number of shift combinations; n=8;

$$x_j = \begin{cases} 1, \text{ if shift combination } j \text{ is assigned to a crewperson,} \\ 0, \text{ otherwise;} \end{cases}$$

$$a_{ij} = \begin{cases} 1, \text{if workshift } i \text{ is assigned in the shift combination } j, \\ 0, \text{otherwise;} \end{cases}$$

Figure 4.5 shows the *A* matrix used for the example set covering problem.

Row i \ Column j	1	2	3	4	5	6	7	8
1	1	0	0	0	1	0	0	0
2	0	0	1	0	0	1	0	0
3	0	0	0	1	0	0	0	1
4	0	1	0	0	1	0	0	0
5	0	0	1	0	0	0	1	0
6	1	0	0	0	0	0	0	1
7	0	1	0	0	0	1	0	0
8	0	0	0	1	0	0	1	0

Figure 4.5: Matrix *A*

Given that the cycle length is equal to four days and each day has two workshifts; there are eight workshifts in the cycle. The eight rows represent the eight workshifts that must be covered. Each column is a shift combination. (These eight shift combinations were generated in Section 4.2.1.4). An element a_{ij} corresponds to the value located in row i and column j; where $i = 1,2,\ldots, 8$ and $j = 1,2,\ldots, 8$. If the value located in the a_{ij} position is one, then shift combination j assigns workshift i. For example, the value of the element a_{11} equals one, so shift combination *one* assigns the day-shift on day *one*. Figure 4.6 shows an example of how to interpret the Matrix *A* using the shift combination D ⇒ O ⇒ N ⇒ O.

		Shift combination	
DAY 1	*day-shift*	1	D
	night-shift	0	
DAY 2	*day-shift*	0	O
	night-shift	0	
DAY 3	*day-shift*	0	N
	night-shift	1	
DAY 4	*day-shift*	0	O
	night-shift	0	

Figure 4.6: Shift Combination D ⇒ O ⇒ N ⇒ O

4.4. Results From the Example Problem

The problem was solved and the output revealed that the minimum workforce size is four people. The shift combinations selected were: D ⇒ O ⇒ N ⇒ O; O ⇒ N ⇒ O ⇒ D; N ⇒ O ⇒ D ⇒ O; and O ⇒ D ⇒ O ⇒ N. Figure 4.7 shows the solution as a shift schedule.

	DAY			
	1	2	3	4
person #1	D	O	N	O
person #2	O	N	O	D
person #3	N	O	D	O
person #4	O	D	O	N

Figure 4.7: Individual Schedules for a Four-day Cycle

Note that this schedule meets the manning requirement which is for at least one person to be assigned to each workshift in the cycle. Therefore, it is possible to use the set covering problem to model personnel scheduling for satellite operations.

4.5 Chapter Summary

This chapter introduced an approach to scheduling personnel without using crews. This approach used the set covering problem.

Using a given set of parameters pertaining to crew shift scheduling, a small test model was formulated as a set covering problem. This test model was entered into a software program called GAMS, and the output report is presented in Appendix A.

The next chapter applies the set covering method to the current personnel scheduling problem for the First Space Operations Squadron.

Chapter V

5. Applying the Set Covering Method to the First Space Operations Squadron

In this chapter, personnel scheduling for the 1SOPS is modeled as a set covering problem. As a first step, this chapter outlines daily manning requirements. Then using the parameters from the current 2/2/2/4 shift schedule and the method to generate cyclical crew shift schedules, other 10-day shift combinations are created to establish a set of potential schedules. In addition, the alternative 5/3 - 5/3 - 5/4 shift schedule is used to generate potential schedules for a 25-day cycle. These potential schedules are then used in set covering models for 10 and 25 day cycles.

5.1 Manning Requirements for the 1SOPS

The First Space Operations Squadron satellite support force is composed of five crews. Each crew is staffed to fill three crew positions: Flight Commander (*FCMDR*), Crew Commander (*CMDR*), and Ground System Operator (*GSO*). Also, the 1SOPS has another position called the Deputy Crew Commander. The Deputy Crew Commander performs the same duties as the Crew Commander and the only difference between the two positions is rank. Since the Crew Commander and Deputy Crew Commander perform the same duties, this research only uses the title "Crew Commander."

5.1.1 Flight Commander (FCMDR). The Flight Commander does not perform any of the support duties for satellite operations. Instead, Flight Commanders supervise crew shift operations. Flight Commanders are responsible for directing emergency procedures, writing performance reports and carrying out administrative duties such as coordinating leave among crew members.

Currently, there are five people assigned to the Flight Commander position. One Flight Commander is assigned to each of the five crews; thus, one Flight Commander is on shift at all times.

5.1.2 Crew Commander (CMDR). Crew Commanders plan satellite contacts, control real-time support operations on satellites, and analyze data received from a satellite. Initially, the duties for a Crew Commander were divided between two crew positions called a Satellite Operations Officer (SOO) and a Planning Analysis Officer (PAO). In response to a shortage of personnel assigned to the crew force, the 1SOPS combined the duties of the two crew positions into one position called the Crew Commander. The 1SOPS received a waiver to combine the two crew positions in December of 1992 (1).

The 1SOPS was established in 1987 to support two satellite programs; the Defense Support Program (DSP) and the Global Positioning System (GPS). Since 1989 the 1SOPS has gradually gained control over a third satellite program, the Defense Meteorological Satellite Program (DMSP).

Currently, the 1SOPS has forty-eight Crew Commanders. To maintain operational support of all three satellite programs, the Crew Commanders become dual qualified in two of the three programs. First, a Crew Commander is trained to support either the DSP or the GPS satellite. Once a Crew Commander is proficient in a primary program, he/she is trained to support DMSP. A waiver to regulation 55-12, dated April 1993, directs that at least four DSP qualified Crew Commanders, three GPS qualified Crew Commanders, and two DMSP qualified Crew Commanders must be on duty during each shift (7). Figure 5.1 illustrates the current distribution of Crew Commanders among five crews.

	CMDRs				
CREW	DSP	DSP & DMSP	GPS	GPS & DMSP	Total Number on Crew
1	2	2	2	2	8
2	3	2	3	2	10
3	3	3	2	3	11
4	3	2	2	2	9
5	3	2	2	3	10
Total Number per Program	14	11	11	12	48

Figure 5.1: CMDR Distribution Among Five Crews

5.1.3 Ground System Operators (GSO). Unlike the Crew Commander position, the GSO position is not program dependent. Each Ground System Operator is capable of supporting any of the three satellite programs. Their primary duty is to set up and maintain the ground interfaces that are necessary for satellite support. The current minimum number of Ground System Operators required during any workshift period is four. This requirement is a waiver to the Space Wing regulation requirement of six GSOs per workshift (7). The distribution of GSO's in the 1SOPS is shown in Figure 5.2.

CREW	GSO
1	6
2	7
3	5
4	6
5	5
Total	29

Figure 5.2: GSO Distribution Among Five Crews

5.2 Generating the Set of Potential Schedules

The next step in the process of formulating the set covering models is to determine a set of potential schedules. Two sets of schedules are generated. The first set contains shift combinations that have a 10-day cycle and the second set contains shift combinations that have a 25-day cycle. The shift combinations generated for the 10-day and 25-day cycles are presented in Appendix B.

5.2.1 The 10-Day Schedules. The parameters used to generate the 10-day shift combinations were determined by examining the current 2/2/2/4 shift schedule. Using Equation (2 - 28) with a given cycle length of ten days and the requirement for each shift combination to have two day-shifts, two swing-shifts, two midnight-shifts and four off-shifts, it is possible to generate 18,900 shift combinations. Since most of these shift combinations do not comply with AFSPACECOM regulations, the method established in Chapter III for generating shift combinations is used to generate a subset of the set of potential 10-day schedules. It was noted in Chapter IV that a problem's size can lengthen the solution process. To ensure reasonable solution times, five-hundred shift combinations were chosen for inclusion in the model.

5.2.2 The 25-Day Schedules. The same process for generating the set of 10-day schedules is used to generate the schedules for the 25-day cycle. The alternate 5/3 - 5/3 - 5/4 shift schedule presented in Chapter III was used to determine the parameters needed to generate other 25-day shift combinations. The total number of possible shift combinations for a 25-day cycle is 2,473,653,742,000; however, only five-hundred shift combinations which comply with AFSPACECOM regulations were actually generated.

5.3 The Set Covering Models

To model the daily personnel requirements of the First Space Operations Squadron, three separate set covering problems were

formulated; the Flight Commander problem, the Ground System Operator problem, and the Crew Commander problem. In all three problems, the objective function minimized the total number of crew personnel needed to meet the workshift requirements of the cycle.

5.3.1 The Flight Commander Problem. From Section 5.1.1, the number of Flight Commanders required each workshift is one. Therefore, every workshift in the cycle requires at least one Flight Commander. Using this constraint and the 10-day and 25-day schedules generated in the last section, the Flight Commander set covering problem formulation is as follows:

Given: $m \equiv$ the total number of workshifts in a cycle;

$n \equiv$ the total number of shift combinations;

$i \equiv$ a specific workshift within the cycle;

$j \equiv$ a specific shift combination;

$$\text{Minimize} \quad \sum_{j=1}^{n} x_j$$

$$\text{Subject to} \quad \sum_{j=1}^{n} a_{ij} x_j \geq 1 \qquad i = 1,2,\ldots,m;$$

$$x_j = 0 \text{ or } 1, \qquad j = 1,2,\ldots, n;$$

Where:

$$x_j = \begin{cases} 1, \text{ if shift combination } j \text{ is assigned to a FCMDR,} \\ 0, \text{ otherwise;} \end{cases}$$

$$a_{ij} = \begin{cases} 1, \text{ if workshift } i \text{ is assigned in the} \\ \quad \text{shift combination } j, \\ 0, \text{ otherwise;} \end{cases}$$

This formulation of the set covering problem allows for the decision variables, x_j, to be assigned values of either zero or one. Thus, this model is referred to as the binary model.

5.3.2 Ground System Operator Problem. Modeling the Ground Systems Operator problem is very similar to the Flight Commander problem. The only difference between the two problems is the minimum manning requirement. Four Ground System Operators are required during any workshift period.

Since the daily manning requirement for the number of GSOs per workshift is four, the upper bound on the number of people assigned to the same shift combination may be any value greater than four. For this model five was chosen to be the upper bound. This means that the decision variables for this model may be assigned any integer value between zero and five.

Using notation similar to that of the binary model for the Flight Commander problem, the integer model for the Ground System Operator problem is as follows:

Given: m ≡ the total number of workshifts in a cycle;

n ≡ the total number of shift combinations;

i ≡ a specific workshift in the cycle;

j ≡ a specific shift combination;

$$\text{Minimize} \quad \sum_{j=1}^{n} x_j$$

$$\text{Subject to} \quad \sum_{j=1}^{n} a_{ij} x_j \geq 4 \qquad i = 1,2,\ldots, m,$$

$$0 \leq x_j \leq 5 \qquad j = 1,2,\ldots, n;$$

Where:

$$x_j = \begin{cases} 1,2,3,4,\text{or } 5 \text{ if shift combination } j \\ \quad \text{is assigned to a GSO,} \\ 0, \text{ otherwise;} \end{cases}$$

$$a_{ij} = \begin{cases} 1, \text{ if workshift } i \text{ is assigned in the} \\ \quad \text{shift combination } j, \\ 0, \text{ otherwise;} \end{cases}$$

5.3.3 The Crew Commander Problem. Like the Ground System Operator problem, the Crew Commander problem is formulated using an integer model. However, this model must be modified to incorporate the fact that Crew Commanders are qualified to support a specific satellite program.

Given that the current minimum number of Crew Commanders on duty during any workshift must be four DSP, three GPS, and two DMSP, the decision variables for this problem are expected to be assigned values between zero and four. To allow for the possibility that a variable could be assigned a value greater than four, the upper bound was set to seven. Thus, the decision variables in the Crew Commander problem may be assigned integer values greater than or equal to zero and less than or equal to seven.

The set covering problem for the Crew Commander position is formulated as follows:

Given: m ≡ the total number of workshifts in a cycle;

n ≡ the total number of shift combinations;

i ≡ a specific workshift within the cycle;

j ≡ a specific shift combination;

Minimize $\sum_{j=1}^{n}(v_j + w_j + x_j + y_j)$

Subject to $\sum_{j=1}^{n}(a_{ij} v_j + a_{ij} w_j) \geq 4 \quad i = 1,\ldots, m;$ (DSP)

$\sum_{j=1}^{n}(a_{ij} x_j + a_{ij} y_j) \geq 3 \quad i = 1,\ldots, m;$ (GPS)

$\sum_{j=1}^{n}(a_{ij} w_j + a_{ij} y_j) \geq 2 \quad i = 1,\ldots, m;$ (DMSP)

$\sum_{j=1}^{n} w_j \leq \sum_{j=1}^{n} v_j$ (Dual Qualified Constraint)

$\sum_{j=1}^{n} y_j \leq \sum_{j=1}^{n} x_j$ (Dual Qualified Constraint)

$0 \leq v_j, w_j, x_j, y_j \leq 7; \quad j = 1,2,\ldots, n$ and $v_j, w_j, x_j, y_j \in Z^+$;

Where:

$$v_j = \begin{cases} 1,2,3,4,5,6, \text{ or } 7 \text{ if shift combination } j \\ \quad \text{is assigned to CMDRs qualified in DSP,} \\ 0, \text{ otherwise;} \end{cases}$$

$$w_j = \begin{cases} 1,2,3,4,5,6, \text{ or } 7 \text{ if shift combination } j \\ \text{is assigned to CMDRs qualified in DSP \& DMSP,} \\ 0, \text{ otherwise;} \end{cases}$$

$$x_j = \begin{cases} 1,2,3,4,5,6, \text{ or } 7 \text{ if shift combination } j \\ \quad \text{is assigned to CMDRs qualified in GPS,} \\ 0, \text{ otherwise;} \end{cases}$$

$$y_j = \begin{cases} 1,2,3,4,5,6, \text{ or } 7 \text{ if shift combination } j \\ \quad \text{is assigned to CMDRs qualified in GPS \& DMSP,} \\ 0, \text{ otherwise;} \end{cases}$$

$$a_{ij} = \begin{cases} 1, \text{ if workshift } i \text{ is assigned in the shift combination } j, \\ 0, \text{ otherwise;} \end{cases}$$

Note that Crew Commanders can be qualified in two systems. Two constraints are added to the integer model to more accurately model current operations. Currently, the 1SOPS has fourteen Crew Commanders qualified in DSP, eleven in DSP & DMSP, eleven in GPS and twelve in GPS & DMSP. The first constraint requires that the total number of DSP & DMSP qualified Crew Commanders selected must be less than or equal to the total number of DSP qualified Crew Commanders selected. The mathematical representation of this constraint is $\sum_{j=1}^{n} w_j \leq \sum_{j=1}^{n} v_j$. The second constraint requires that the total number of GPS & DMSP qualified Crew Commanders selected must be

less than or equal to the total number of GPS qualified Crew Commanders selected, or $\sum_{j=1}^{n} y_j \leq \sum_{j=1}^{n} x_j$.

5.4 Stopping Requirements for the Solution Process

Each model described in Section 5.3 was formulated and solved using the GAMS/ZOOM solver on a VAX/VMS computer system. The three criteria used to terminate a program were: an optimal tolerance, an iteration limit and a resource limit.

Quite often, solving an integer programming problem requires an enormous amount of time to find an optimal solution; thus, it is sometimes reasonable to settle for a solution that is within a specified percent of an upper bound. The bound is established by relaxing the problem's integer requirements and solving it as a linear program. When the integer program is executed, the solver will stop once it finds an integer solution that is within the specified tolerance. The standard tolerance used is 0.1. This means the program will stop on the first solution that is found which has an objective function value within ten percent of the bound. Unless otherwise stated, each model used a tolerance of ten percent.

The iteration limit causes the solver to stop after a specified number of iterations have been completed. The resource limit stops program execution after a specified number of units of processor time have been used. The values set for these two stopping criteria varied. If the results from executing a program did not provide a solution within the optimal tolerance, then the values for either the iteration limit or resource limit were increased to allow the solution to fall within the tolerance.

5.5 Research Results

5.5.1 The Flight Commander. Two binary models were executed for scheduling personnel for the Flight Commander position. One model used a 10-day cycle and the other used a 25-day cycle.

5.5.1.1 The 10-Day Model. Initially, the integer requirements on the decision variable were relaxed and the model was solved as a linear program with an upper bound of one on the decision variable. The optimal solution was integer, and less than two minutes were required to reach optimality.

From the set of five-hundred possible shift combinations, shift combinations 1,3,5,7, and 9 were selected. Figure 5.3 shows the Flight Commander shift schedule. Note that the letter "C" is used to represent the term "shift combination *j*."

	DAYS IN CYCLE										
C	1	2	3	4	5	6	7	8	9	10	FCMDR
1	D	D	S	S	M	M					#1
3	S	S	M	M					D	D	#2
5	M	M					D	D	S	S	#3
7					D	D	S	S	M	M	#4
9			D	D	S	S	M	M			#5

Figure 5.3: FCMDR Shift Schedules for a 10-Day Cycle

The results show that the minimum number of Flight Commanders needed to meet the daily manning requirements for a 10-day cycle is five. This result is not surprising since all the schedules are equivalent. That is, all the shift combinations contain two day-shifts, two swing-shifts, two midnight-shifts and four off-shifts (recall the analysis conducted in Chapter II). When WS = 3, there is one day-shift each day in the cycle.

Therefore, the total number of day-shifts in the cycle equals the cycle length. Since each day-shift is worked by one Flight Commander, then

$$\sum_{i=1}^{FC} DS_i = CL \; ; \qquad (5 - 1)$$

where FC represents the total number of Flight Commanders.

Since all shift combinations are equivalent, $DS_1 = DS_2 = \ldots = DS_{FC-1} = DS_{FC}$. This yields the following equation:

$$DS_i \times FC = CL; \; \forall \; i = 1, 2, \ldots, FC. \qquad (5 - 2)$$

Solving for the FC, the number of Flight Commanders needed to maintain a shift schedule of a given cycle length and a specified number of day-shifts per Flight Commander is

$$FC = \frac{CL}{DS_i} \qquad (5 - 3)$$

Thus, for a 10-day cycle having two day-shifts, the number of Flight Commanders required to build a shift schedule is five.

In order to generate a shift schedule that uses the smallest possible number of Flight Commanders, again recall the analysis conducted in Chapter II. When $WS = 3$, at minimum, four Flight Commanders must be used to create a shift schedule to cover each workshift and give off-shift time. Using Equation (5 - 3), when $FC = 4$ and $DS_i = 2$, the cycle length is eight ($CL = 8$).

Since the cycle length is the total number of consecutive days required to complete the sequence of workshifts and off-shifts, when $CL = 8$, $DS_i = 2$, $SS_i = 2$, and $MS_i = 2$, then the number of off-shifts, OS_i, must equal two. This information may be used to generate shift combinations for an 8-day cycle. Thus, it is possible to generate a shift

schedule that uses four Flight Commanders to meet the 1SOPS daily requirements.

5.5.1.2 The 25-Day Model. The solution time for this model was minimal. Within two minutes, the computer was able to obtain an optimal zero-one integer solution. The minimum number of Flight Commanders needed to meet the daily manning requirements of a 25-day cycle is five. Using Equation (5 - 3), when $CL = 25$ and $DS_i = 5$ the number of Flight Commanders required is five. The shift combinations selected formed the shift schedule shown in Figure 5.4.

	DAYS IN CYCLE																									
C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	FCMDR
1	D	D	D	D	D				S	S	S	S	S				M	M	M	M	M					#1
6				S	S	S	S	S				M	M	M	M	M					D	D	D	D	D	#2
11	S	S	S				M	M	M	M	M					D	D	D	D	D				S	S	#3
16		M	M	M	M	M					D	D	D	D	D				S	S	S	S	S			#4
21	M					D	D	D	D	D				S	S	S	S	S				M	M	M	M	#5

Figure 5.4: FCMDR Shift Schedules for a 25-Day Cycle

To use the smallest possible number of Flight Commanders when WS = 3, a minimum of four Flight Commanders are necessary. Therefore, using Equation (5 - 3), when $FC = 4$ and $DS = 5$, the cycle length would have to equal twenty days ($CL = 20$).

5.5.1.3 Observations, Suggestions, and Conclusions. Neither the current method or the set covering method for scheduling Flight Commanders accounts for the possibility of a Flight Commander being absent from duty. An absence from duty may include leave, temporary duty, training, evaluation or illness. The 1SOPS has a total of

five Flight Commanders. Currently the 1SOPS uses a senior Crew Commander to serve in the Deputy Flight Commander position. In the absence of a Flight Commander, the Deputy Flight Commander acts as the crew's Flight Commander and also performs his/her duties as a Crew Commander.

The current shift schedule and the two shift schedules that were generated each require five Flight Commander to support operations; thus, no benefit seems to be gained from modeling the Flight Commander position as a set covering problem. Instead, the only way to reduce the number of Flight Commanders would be to use the mathematical relationships developed in Chapter II to determine the smallest possible number of Flight Commanders needed to meet 1SOPS requirements. Then generate an acceptable cyclical shift schedule based on the method shown in Chapter III and assign one Flight Commander to each shift combination in the shift schedule.

5.5.2 The Ground Systems Operator. Two integer models were solved for scheduling personnel for the Ground System Operator position. One model used a 10-day cycle and the other a 25-day cycle.

5.5.2.1 The 10-Day Model. The results are shown in Figure 5.5.

The shift schedule requires twenty Ground System Operators. Currently, the 1SOPS has twenty-nine GSOs. Thus, nine of the GSOs are not needed to support normal operations. Some or all of the remaining Ground System Operators may be used to supplement the schedule or perform other squadron duties.

The shift combinations shown in Figure 5.5 are the same shift combinations that were selected to generate the Flight Commander's schedule for a10-day cycle. Thus, combining the Flight Commanders

shift schedule with the Ground System Operator shift schedule would produce five crews having one Flight Commander and four GSOs.

	DAYS IN CYCLE										
C	1	2	3	4	5	6	7	8	9	10	GSO
1	D	D	S	S	M	M					#1
1	D	D	S	S	M	M					#2
1	D	D	S	S	M	M					#3
1	D	D	S	S	M	M					#4
3	S	S	M	M					D	D	#5
3	S	S	M	M					D	D	#6
3	S	S	M	M					D	D	#7
3	S	S	M	M					D	D	#8
5	M	M					D	D	S	S	#9
5	M	M					D	D	S	S	#10
5	M	M					D	D	S	S	#11
5	M	M					D	D	S	S	#12
7					D	D	S	S	M	M	#13
7					D	D	S	S	M	M	#14
7					D	D	S	S	M	M	#15
7					D	D	S	S	M	M	#16
9			D	D	S	S	M	M			#17
9			D	D	S	S	M	M			#18
9			D	D	S	S	M	M			#19
9			D	D	S	S	M	M			#20

Figure 5.5: GSO Shift Schedule for a 10-Day Cycle

5.5.2.2 The 25-Day Model. The results from solving the integer model of the 25-day cycle are shown in Figure 5.6.

	DAYS IN CYCLE																									
C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	GSO
2	D	D	D	D				S	S	S	S	S				M	M	M	M	M					D	#1
2	D	D	D	D				S	S	S	S	S				M	M	M	M	M					D	#2
2	D	D	D	D				S	S	S	S	S				M	M	M	M	M					D	#3
2	D	D	D	D				S	S	S	S	S				M	M	M	M	M					D	#4
7			S	S	S	S	S				M	M	M	M	M					D	D	D	D	D		#5
7			S	S	S	S	S				M	M	M	M	M					D	D	D	D	D		#6
7			S	S	S	S	S				M	M	M	M	M					D	D	D	D	D		#7
7			S	S	S	S	S				M	M	M	M	M					D	D	D	D	D		#8
12	S	S				M	M	M	M	M					D	D	D	D	D				S	S	S	#9
12	S	S				M	M	M	M	M					D	D	D	D	D				S	S	S	#10
12	S	S				M	M	M	M	M					D	D	D	D	D				S	S	S	#11
12	S	S				M	M	M	M	M					D	D	D	D	D				S	S	S	#12
17	M	M	M	M	M					D	D	D	D	D				S	S	S	S	S				#13
17	M	M	M	M	M					D	D	D	D	D				S	S	S	S	S				#14
17	M	M	M	M	M					D	D	D	D	D				S	S	S	S	S				#15
17	M	M	M	M	M					D	D	D	D	D				S	S	S	S	S				#16
22					D	D	D	D	D				S	S	S	S	S				M	M	M	M	M	#17
22					D	D	D	D	D				S	S	S	S	S				M	M	M	M	M	#18
22					D	D	D	D	D				S	S	S	S	S				M	M	M	M	M	#19
22					D	D	D	D	D				S	S	S	S	S				M	M	M	M	M	#20

Figure 5.6: GSO Shift Schedule for a 25-Day Cycle

The shift combinations selected in Figure 5.6 follow the same shift sequence as the shift combinations selected for the Flight Commander problem; the only difference is that the pattern is offset by one day. An option would be to alter each shift combination in Figure 5.6 forward one day. That is, move the shift assigned to day *one* to day *two*, and the shift assigned to day *two* to day *three*, and so on through day *twenty-five*. The shift assigned to the twenty-fifth day must move to day *one* to

complete the cycle. This would align the twenty GSO shift combinations with the Flight Commander's shift combinations. Thus, five crews would be formed and each would have one Flight Commander and four Ground System Operators.

5.5.2.3 Observations, Suggestions, and Conclusions.

Both the 10-day and 25-day integer models were able to produce shift schedules that are consistent with current operations. Both the 10-day model and the 25-day model select five equivalent shift combinations and assign four Ground Systems Operators to each shift combination. Thus, each model requires a minimum of twenty GSOs to support the shift schedule.

Again it is possible to produce this result using the mathematical relationships developed in Chapter II. When WS = 3, there is one day-shift each day in the cycle. Therefore, the total number of day-shifts in the cycle equals the cycle length. Since each day-shift is worked by at least four Ground System Operators, then

$$\sum_{i=1}^{GS} \frac{DS_i}{4} = CL \; ; \qquad (5 - 4)$$

where GS represents the total number of Ground System Operators.

Since all shift combinations are equivalent, $DS_1 = DS_2 = \ldots = DS_{GS-1} = DS_{GS}$. This yields the following equation:

$$\frac{DS_i}{4} \text{ x } GS = CL; \; \forall \; i = 1, 2, \ldots, GS. \qquad (5 - 5)$$

Solving for the *GS*, the number of Ground System Operators needed to maintain a shift schedule of a given cycle length and a specified number of day-shifts per four Ground System Operators is

$$GS = \frac{CL \times 4}{DS_i} \qquad (5 - 6)$$

Thus, for a 10-day cycle having two day-shifts, the number of Ground System Operators required to build a shift schedule is twenty and for a 25-day cycle with five day-shifts, the number of Ground System Operators required is twenty.

In order to generate a shift schedule that uses the smallest possible number of Ground System Operators, again recall the analysis conducted in Chapter II. When $WS = 3$ and a minimum of four people is needed per workshift then, at minimum, sixteen Ground System Operators must be used to create a shift schedule to cover each workshift and give off-shift time. Using Equation (5 - 6), when $GS = 16$ and $DS = 2$, the cycle length is eight (CL = 8) and when GS = 16 and $DS = 5$ the cycle length is twenty (CL = 20).

5.5.3 The Crew Commander Models. The Crew Commander problem is more complicated than either the Flight Commander problem or the Ground System Operator problem because each Crew Commander is qualified in a specific satellite program. A Crew Commander may only support a satellite that he/she is qualified to support. Thus, Crew Commanders must be distributed among the workshift periods so that their qualifications meet the needs of each workshift period.

Under current operations, 48 Crew Commanders are distributed among five crews as shown in Figure 5.1. The current coverage meets the minimum requirements for satellite support; however, the potential problem with this current method of assigning personnel is the possibility of one or more Crew Commanders having to be absent from duty. Crew *one* stands out as having the greatest potential for a

problem. Note that if one of the Crew Commanders qualified in DSP is absent from duty, then the first crew will no longer meet the minimum requirement of having four DSP qualified Crew Commanders assigned to a workshift.

As seen previously with the Ground System Operator models, the set covering method provides the ability to determine a shift schedule that assigns the minimum number of people necessary to meet each workshift requirement. Two integer models were used to examine the Crew Commander problem: the integer model for the 10-day cycle and the integer model for the 25-day cycle.

5.5.3.1 The 10-Day Model. This integer model was formulated using a set of five-hundred potential schedules. The first run of this model was unable to find an integer solution. The program was terminated because it exceeded its resource limit. On the next run of the model, the value for the tolerance was changed from ten percent to fifty percent. This change allowed the program to find an integer solution that was within fifty percent of the calculated lower bound. Using the results from this second run, two-hundred ninety schedules were eliminated from the original set of five-hundred to reduce the time it would take to solve the problem. The remaining two-hundred ten schedules were used to a formulate a smaller set covering model. The tolerance was reset to ten percent and the model was resolved.

The solution to this model requires thirty-six Crew Commanders. The breakdown of the number of program-specific Crew Commanders is shown in Figure 5.7 and the shift combinations that were selected are presented in Figure 5.8.

	CREW COMMANDERS			
	DSP	DSP & DMSP	GPS	GPS & DMSP
10-Day Model	10	10	8	8

Figure 5.7: Total Number of Program-Specific Crew Commanders

These results are significant. Since the Crew Commanders have various program qualifications, it is not a simple process to just generate a cyclical shift schedule and assign the minimum required number of personnel to each cycle. The set covering model provides a way to determine a shift schedule that will meet the workshift requirements with the minimum number of personnel. The results for the 10-day model shows that no more than thirty-six Crew Commanders are required to support operations. Since the 1SOPS currently has forty-eight crew commanders, the remaining twelve Crew Commanders are not needed to support normal operations. Instead, any extra personnel may be used to supplement the shift schedule or perform other squadron duties.

The results from the model used the shift combinations 1,3,5,7, and 9. These shift combinations are consistent with the shift combinations chosen for the Flight Commanders and the Ground Systems Operators. Thus, this allows the 1SOPS to maintain its crew environment.

	DAYS IN CYCLE											
C	1	2	3	4	5	6	7	8	9	10	CMDR	
3	S	S	M	M					D	D	#1	DSP
3	S	S	M	M					D	D	#2	DSP
3	S	S	M	M					D	D	#3	DSP
3	S	S	M	M					D	D	#4	DSP
7					D	D	S	S	M	M	#5	DSP
7					D	D	S	S	M	M	#6	DSP
7					D	D	S	S	M	M	#7	DSP
7					D	D	S	S	M	M	#8	DSP
9			D	D	S	S	M	M			#9	DSP
9			D	D	S	S	M	M			#10	DSP
1	D	D	S	S	M	M					#11	DSP & DMSP
1	D	D	S	S	M	M					#12	DSP & DMSP
1	D	D	S	S	M	M					#13	DSP & DMSP
1	D	D	S	S	M	M					#14	DSP & DMSP
5	M	M					D	D	S	S	#15	DSP & DMSP
5	M	M					D	D	S	S	#16	DSP & DMSP
5	M	M					D	D	S	S	#17	DSP & DMSP
5	M	M					D	D	S	S	#18	DSP & DMSP

	DAYS IN CYCLE											
C	1	2	3	4	5	6	7	8	9	10		
9			D	D	S	S	M	M			#19	DSP & DMSP
9			D	D	S	S	M	M			#20	DSP & DMSP
1	D	D	S	S	M	M					#21	GPS
1	D	D	S	S	M	M					#22	GPS
3	S	S	M	M					D	D	#23	GPS
5	M	M					D	D	S	S	#24	GPS
5	M	M					D	D	S	S	#25	GPS
5	M	M					D	D	S	S	#26	GPS
9			D	D	S	S	M	M			#27	GPS
9			D	D	S	S	M	M			#28	GPS
1	D	D	S	S	M	M					#29	GPS & DMSP
3	S	S	M	M					D	D	#30	GPS & DMSP
3	S	S	M	M					D	D	#31	GPS & DMSP
7					D	D	S	S	M	M	#32	GPS & DMSP
7					D	D	S	S	M	M	#33	GPS & DMSP
7					D	D	S	S	M	M	#34	GPS & DMSP
9			D	D	S	S	M	M			#35	GPS & DMSP
9			D	D	S	S	M	M			#36	GPS & DMSP

Figure 5.8: CMDR Shift Schedules for a 10-Day Cycle

5.5.3.2 The 25-Day Model. The increase in the cycle length in conjunction with the complexity of the Crew Commander problem had a substantial effect on the amount of computer time needed to solve this model. This model ran for four days and six hours and was unable to produce any usable results. In order to reduce the amount of time needed to obtain integer results, the set of potential schedules had to be reduced in size. The results from the Flight Commander model and the Ground System Operator model were used to selectively eliminate cycle combinations from the set of covering solutions. Four hundred cycle combinations had to be cut from the model in order to solve the model and provide usable results.

The solution shows that no more than thirty-six Crew Commanders are required. Figure 5.9 shows the breakdown of personnel and Figures 5.10a and 5.10b list the shift cycles that were chosen to make-up the shift schedule.

	CREW COMMANDERS			
	DSP	DSP & DMSP	GPS	GPS & DMSP
25-Day Model	10	10	8	8

Figure 5.9: Total Number of Program-Specific Crew Commanders

	DAYS IN CYCLE																										
C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	CMDR	
11	S	S	S				M	M	M	M	M					D	D	D	D	D				S	S	#1	DSP
11	S	S	S				M	M	M	M	M					D	D	D	D	D				S	S	#2	DSP
11	S	S	S				M	M	M	M	M					D	D	D	D	D				S	S	#3	DSP
11	S	S	S				M	M	M	M	M					D	D	D	D	D				S	S	#4	DSP
16		M	M	M	M	M					D	D	D	D	D				S	S	S	S	S			#5	DSP
16		M	M	M	M	M					D	D	D	D	D				S	S	S	S	S			#6	DSP
16		M	M	M	M	M					D	D	D	D	D				S	S	S	S	S			#7	DSP
21	M					D	D	D	D	D				S	S	S	S	S				M	M	M	M	#8	DSP
21	M					D	D	D	D	D				S	S	S	S	S				M	M	M	M	#9	DSP
21	M					D	D	D	D	D				S	S	S	S	S				M	M	M	M	#10	DSP
1	D	D	D	D	D				S	S	S	S	S				M	M	M	M	M					#11	DSP & DMSP
1	D	D	D	D	D				S	S	S	S	S				M	M	M	M	M					#12	DSP & DMSP
1	D	D	D	D	D				S	S	S	S	S				M	M	M	M	M					#13	DSP & DMSP
1	D	D	D	D	D				S	S	S	S	S				M	M	M	M	M					#14	DSP & DMSP
6				S	S	S	S	S				M	M	M	M	M					D	D	D	D	D	#15	DSP & DMSP
6				S	S	S	S	S				M	M	M	M	M					D	D	D	D	D	#16	DSP & DMSP
6				S	S	S	S	S				M	M	M	M	M					D	D	D	D	D	#17	DSP & DMSP
6				S	S	S	S	S				M	M	M	M	M					D	D	D	D	D	#18	DSP & DMSP

Figure 5.10a: CMDR Shift Schedule for a 25-Day Cycle

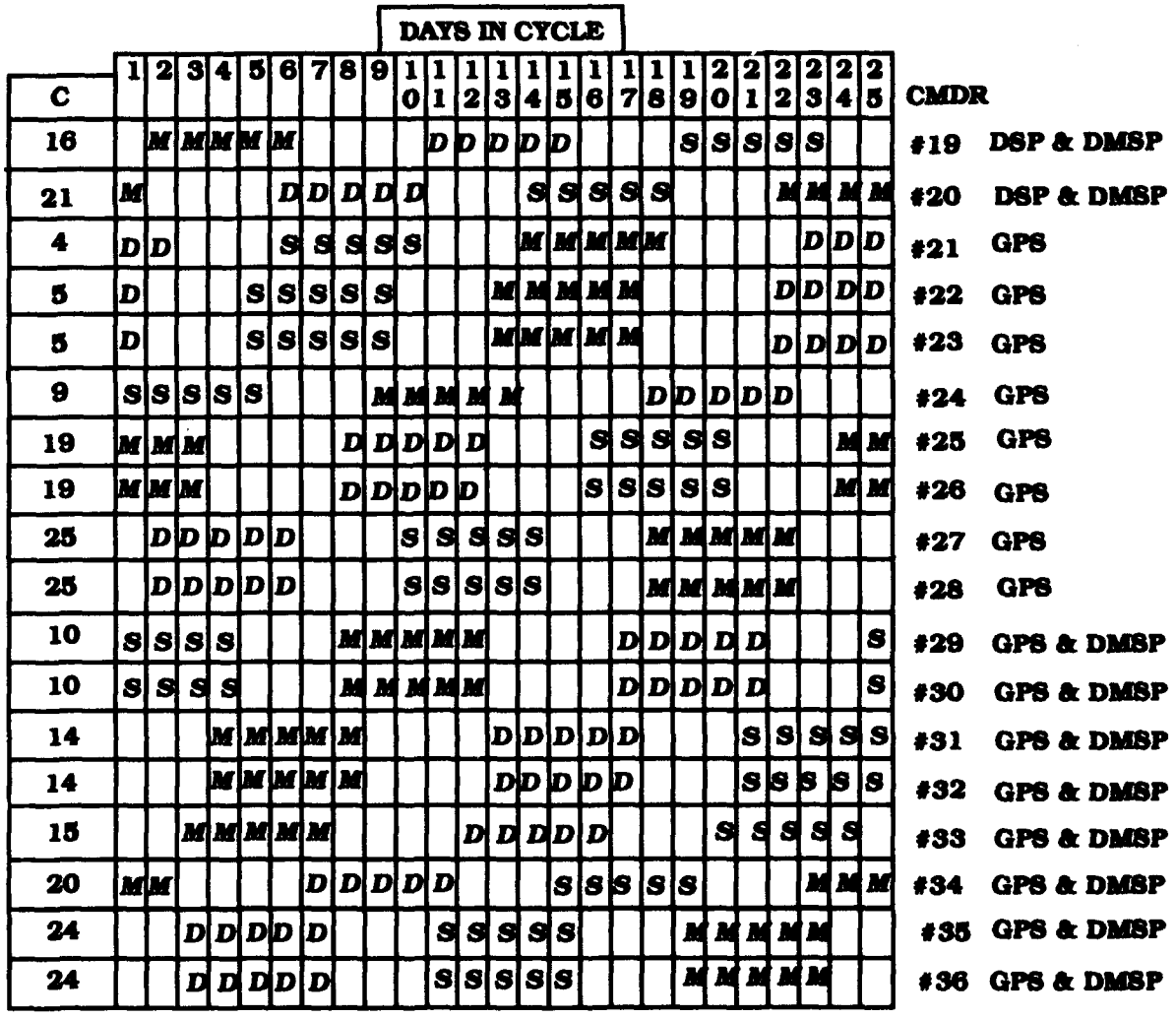

Figure 5.10b: CMDR Shift Schedule for a 25-Day Cycle

The shift combinations selected for the Crew Commanders have the same shift sequence as the Flight Commanders and Ground System Operators; however, their shift combinations are offset. The offsets among the Crew Commander schedules vary; thus, starting their shift sequence on a different day will not cause the shift combinations to match up with the other crew positions' schedules. Hence, a pure crew force structure may not be formed with the Flight Commanders or the Ground System Operators using this solution. The best that can happen is a "pseudo-crew" environment. The Crew Commander's schedules and the Flight Commander's schedules do overlap, so each Crew Commander may be supervised by a particular Flight Commander. For example, the Crew Commanders assigned to shift combination #4 could administratively be assigned to the Flight Commander assigned to shift combination #1. The Crew Commanders assigned to shift cycle #9 may fall under the command of the Flight Commander assigned to shift cycle 11. Although the Flight Commanders will not see all their assigned Crew Commanders everyday, they would still have the opportunity to review the performance of each Crew Commander on a regular basis.

5.6 Chapter Summary

To model the daily manning requirements for the First Space Operations Squadron, three separate set covering problems were formulated; the Flight Commander problem, the Crew Commander problem, and the Ground System Operator problem. In all three problems, the objective function minimized the total number of crew personnel needed to meet the workshift requirements of the cycle.

After solving each model, the results indicated that using the set covering approach will provide the best minimum solution for a given cycle length. Set covering is best suited for scheduling the Crew Commander position. Since Crew Commanders are qualified to support specific satellite programs, it is more difficult to manually match personnel qualifications with the needs of each workshift. Simply assigning people to a crew shift schedule does not guarantee the lowest

number of personnel will be used to meet the minimum workshift requirements. Using the set covering method provides a shift schedule which minimizes the total number of Crew Commanders needed to meet the requirements for a given cycle length.

The major drawback to this model is that it gives the minimum requirement for a given cycle length and then only, if all possible cycles are used in the model. Due to run time requirements, this last requirement is not feasible. Note that a minimum number required for a given cycle length does not guarantee that this is the smallest number required for all possible cycle lengths.

Another drawback to using the set covering method was the amount of time required for the computer to solve the problem. If more constraints were placed on the problem or if the size of the problem increased, the amount of time required for the computer to solve the problem increased. The Crew Commander model for the 25-day cycle was too large to be solved in a reasonable amount of time, (meaning less than a few days). As a trade-off, a number of potential schedules had to be eliminated from the model. Since potential schedules were eliminated, the resulting solution may not be optimal.

Chapter VI

6. Summary and Suggestions for Further Research

The day-to-day mission objective of Space Operations Squadrons is to support military satellite systems. Military satellite systems provide strategic and tactical space support to many aspects of military operations. It is essential for these military satellite systems to operate twenty-four hours-a-day, seven days-a-week. The personnel assigned to Space Operations Squadrons ensure the operability of US military satellites by performing continuous support operations. Currently, each SOPS is manned with trained personnel who are assigned to permanent crews. The crews are then assigned to support operations based on a cyclical crew shift schedule.

The scheduling problem associated with conducting continuous satellite support operations in Satellite Operations Squadrons is threefold. The first problem is finding cyclical crew shift schedules that meet daily workforce manning requirements, adhere to current AFSPACECOM regulations, contain a minimum number of workshift changes within a period of consecutive duty days, and maximize the non-duty time allowed between duty shifts. The second problem is how to choose the best shift schedule. Finally, the third problem is to meet the scheduling requirements stated in the first problem using the least number of satellite support personnel.

6.1 Summary

The first objective was to be able to generate feasible crew shift schedules for Space Operations Squadrons given workforce requirements and scheduling constraints. This step required developing mathematical relationships that are inherent to cyclical crew shift schedules. Chapter II presented these relationships, which were then used in Chapter III to develop a method to generate alternate cyclical crew shift schedules.

Using parameters related to the currently used crew shift schedule, an alternative cyclical crew shift schedule that simultaneously minimizes the number of workshift changes within a period of consecutive duty days and maximizes the amount of non-duty time allowed between duty shifts was created. The alternate crew shift schedule is referred to as the 5/3 - 5/3 - 5/4 shift schedule.

The second research objective was to establish a set of criteria to compare crew shift schedules. Space Operations Squadrons currently do not have a set of criteria to compare crew shift schedules. This research suggests a set of five criteria for measuring the effectiveness of a crew shift schedule: coverage, workforce size, compliance, workshift changes, and off-shift periods. Thus, an effective schedule provides the required minimum amount of shift coverage with the smallest number of people on the crew force, complies with applicable AFSPACECOM regulations, minimizes the number of changes among contiguous workshifts, and maximizes the number of continual off-shifts up to the amount of time allowed by regulations.

Based on this set of criteria, the current 2/2/2/4 shift schedule was compared to the alternate shift schedule. The result was that the alternate schedule was more effective than the current schedule because it minimizes the number of workshift changes during consecutive workdays. The alternate schedule contains zero changes during its five consecutive duty days compared to the current shift schedule with two workshift changes in each set of six consecutive duty days.

The third research objective was to test an alternate approach to scheduling personnel in the 1SOPS. The purpose of this step of the research was to observe the effect that individually scheduling SOPS personnel had on the total number of personnel needed to meet the daily satellite support requirements. Chapter IV introduced the set covering problem and provided a small example problem to show that SOPS crew scheduling requirements may be mathematically modeled using set covering.

Chapter V analyzed and presented the results from testing the set covering model using data collected from the First Space Operations Squadron and shift schedules generated for a 10-day cycle and a 25-day cycle.

To model the daily manning requirements for the First Space Operations Squadron, three separate set covering problems were formulated; the Flight Commander problem, the Crew Commander problem, and the Ground System Operator problem. In all three problems, the objective function minimized the total number of crew personnel needed to meet the workshift requirements of the cycle.

The Flight Commander problem resulted in no change in the number of Flight Commanders used to support the shift schedule. A minimum of five Flight Commanders are needed to meet the daily manning requirements for a 10-day cycle. A way to reduce the number of Flight Commanders needed to support satellite operations is by using the relationships developed in Chapter II to determine the smallest possible number of Flight Commanders needed to meet daily workshift requirements. Using these relationships, there is a feasible schedule requiring only four Flight Commanders.

Both the Flight Commander problem and the Ground System Operator problem can be solved more simply by generating a cyclical crew shift schedule based on the method established in Chapter III. Once the shift schedule is generated, the scheduler may assign the minimum number of personnel required per workshift to each shift combination.

Chapter V showed that set covering is best suited for scheduling the Crew Commander position. The Crew Commanders are qualified to support specific satellite programs. Thus, it is more difficult to manually match personnel qualifications with the needs of each workshift. The set covering method provides a shift schedule which minimizes the total number of Crew Commanders that make-up the shift schedule. Currently, the 1SOPS uses 48 Crew Commanders to support five crews.

Using the set covering method, a shift schedule was developed which required thirty-six Crew Commanders. This leaves twelve extra Crew Commanders that may be used to supplement the schedule or perform other squadron duties.

The cost of using the set covering model is the potential loss of the crew environment. The shift schedules resulting from the three crew position models formulated using the 10-day cycle matched up so a crew environment was maintained. However, the shift schedules for the crew positions having a 25-day cycle did not match. At best, the Crew Commander cycles would overlap the cycles of the Flight Commanders and Ground System Operators.

6.2 Suggestions for Further Research

Chapter III presented a method to generate alternative cyclical crew shift schedules. This method is a manual method and is very time consuming when numerous schedules must be generated. Therefore, one suggestion for further research is to use the mathematical relationships developed in Chapter II, the constraints directed by AFSPACECOM regulations, and the method presented in Chapter III to generate cyclical crew shift schedules to develop an interactive computer program which generates feasible cyclical crew shift schedules.

Since the shift combinations generated for the set covering models were cyclical shift schedules, the solution for each model produced a cyclical shift schedule. This research did not take into account choosing non-cyclical shift schedules from the set of potential solutions. Thus, another suggestion for further research is to use non-cyclical shift combinations for the set of potential solutions. The shift combinations may be formulated to include personal leave preferences, temporary duty assignments, and training periods.

A drawback of using the set covering method is that it gives the minimum requirement for a given cycle length and then, only if all possible schedules are used in the model. Due to time requirements, it

is not feasible to use all possible schedules for a given cycle length. The Crew Commander models were too large to be solved in a reasonable amount of time, so a number of potential schedules had to be eliminated from the model. By eliminating potential schedules the potential for cutting out the optimal solution exists. The approach used to eliminate schedules from the set of potential solutions was to use results from previous models and make educated guesses as to which schedules may provide an acceptable solution. A suggestion for further research is to create a computer program to perform the schedule elimination process.

Appendix A

This appendix contains the GAMS output report for the example problem presented in Chapter IV.

The report output is sectioned into eight parts. The first six sections pertain to preparing the model for execution. The first section of the report is an echo print of the example problem formatted as a GAMS program. The next part on page A-3, is called a symbol listing. This section lists all the symbols used in the program and identifies them. Page A-4 shows a shortened equation listing, which displays the objective function and first three equations of the example program. The remaining constraint equations are not printed in the output report. The same is true for the next section called a column listing; only the first three columns of the program are printed. The model statistics, found on page A-6, shows the size of the model and include the number of equations and discrete variables.

The final two sections of the report output provide information about the solution that GAMS found using the given parameters. The solution report may be found on pages A-7 and A-8. This section begins with a solve summary, which gives the attributes about the solution that is found. It contains the solver status, model status, objective value, resource usage, and iteration counts. The remaining information found in the solution report is the line-by-line solving details from GAMS.

The final part of the output is called a report summary. This part displays the solution.

TEST1

```
 3
 4  SETS
 5       I total number of shifts in cycle  / SHIFT1*SHIFT8 /
 6       J subset of feasible schedules     / SCH1*SCH8 / ;
 7
 8  PARAMETERS
 9       R(I) right hand side
10          / SHIFT1    1
11            SHIFT2    1
12            SHIFT3    1
13            SHIFT4    1
14            SHIFT5    1
15            SHIFT6    1
16            SHIFT7    1
17            SHIFT8    1 /
18
19      TABLE A(I,J) schedule j where shift i is 1 if scheduled to work
20
21                  SCH1   SCH2   SCH3   SCH4   SCH5   SCH6   SCH7   SCH8
22          SHIFT1   1      0      0      0      1      0      0      0
23          SHIFT2   0      0      1      0      0      1      0      0
24          SHIFT3   0      0      0      1      0      0      0      1
25          SHIFT4   0      1      0      0      1      0      0      0
26          SHIFT5   0      0      1      0      0      0      1      0
27          SHIFT6   1      0      0      0      0      0      0      1
28          SHIFT7   0      1      0      0      0      1      0      0
29          SHIFT8   0      0      0      1      0      0      1      0;
30
31  VARIABLES
32      X(J)  will be 1 if schedule j is selected
33      Z     total schedules that are worked ;
34
35  BINARY VARIABLE X;
36
37  EQUATIONS
38       WORKFORCE   defines objective function
39       REQUIRE(I)  defines requirement for each shift ;
40
41  WORKFORCE .. Z =E= SUM( J,  X(J) ) ;
42
43  REQUIRE(I) ..  SUM( J, A(I,J)*X(J) ) =G= R(I) ;
44
45  MODEL TEST1 /ALL/ ;
46
47  SOLVE TEST1 USING MIP MINIMIZING Z ;
48
49  DISPLAY  X.L ;
50
```

TEST1
SYMBOL LISTING

SYMBOL	TYPE	REFERENCES						
A	PARAM	DECLARED	19	DEFINED	19	REF	43	
I	SET	DECLARED	5	DEFINED	5	REF	9	
		19	39	2*43	CONTROL	43		
J	SET	DECLARED	6	DEFINED	6	REF	19	
		32	41	2*43	CONTROL	41	43	
R	PARAM	DECLARED	9	DEFINED	10	REF	43	
REQUIRE	EQU	DECLARED	39	DEFINED	43	IMPL-ASN	47	
		REF	45					
TEST1	MODEL	DECLARED	45	DEFINED	45	IMPL-ASN	47	
		REF	47					
WORKFORCE	EQU	DECLARED	38	DEFINED	41	IMPL-ASN	47	
		REF	45					
X	VAR	DECLARED	32	IMPL-ASN	47	REF	35	
		41	43	49				
Z	VAR	DECLARED	33	IMPL-ASN	47	REF	41	
		47						

SETS

I	TOTAL NUMBER OF SHIFTS IN CYCLE
J	SUBSET OF FEASIBLE SCHEDULES

PARAMETERS

A	SCHEDULE J WHERE SHIFT I IS 1 IF SCHEDULED TO WORK
R	RIGHT HAND SIDE

VARIABLES

X	WILL BE 1 IF SCHEDULE J IS SELECTED
Z	TOTAL SCHEDULES THAT ARE WORKED

EQUATIONS

REQUIRE	DEFINES REQUIREMENT FOR EACH SHIFT
WORKFORCE	DEFINES OBJECTIVE FUNCTION

MODELS

TEST1

COMPILATION TIME = 0.560 SECONDS

```
TEST1
EQUATION LISTING    SOLVE TEST1 USING MIP FROM LINE 47

---- WORKFORCE   =E=  DEFINES OBJECTIVE FUNCTION

WORKFORCE..  - X(SCH1) - X(SCH2) - X(SCH3) - X(SCH4) - X(SCH5) - X(SCH6)
      - X(SCH7) - X(SCH8) + Z =E= 0 ;

---- REQUIRE     =G=  DEFINES REQUIREMENT FOR EACH SHIFT

REQUIRE(SHIFT1)..  X(SCH1) + X(SCH5) =G= 1 ;

REQUIRE(SHIFT2)..  X(SCH3) + X(SCH6) =G= 1 ;

REQUIRE(SHIFT3)..  X(SCH4) + X(SCH8) =G= 1 ;

REMAINING 5 ENTRIES SKIPPED
```

```
TEST1
COLUMN LISTING      SOLVE TEST1 USING MIP FROM LINE 47


---- X           WILL BE 1 IF SCHEDULE J IS SELECTED


X(SCH1)
                 (.LO, .L, .UP = 0, 0, 1)
        -1       WORKFORCE
         1       REQUIRE(SHIFT1)
         1       REQUIRE(SHIFT6)

X(SCH2)
                 (.LO, .L, .UP = 0, 0, 1)
        -1       WORKFORCE
         1       REQUIRE(SHIFT4)
         1       REQUIRE(SHIFT7)

X(SCH3)
                 (.LO, .L, .UP = 0, 0, 1)
        -1       WORKFORCE
         1       REQUIRE(SHIFT2)
         1       REQUIRE(SHIFT5)

REMAINING 5 ENTRIES SKIPPED


---- Z           TOTAL SCHEDULES THAT ARE WORKED


Z
                 (.LO, .L, .UP =  -INF, 0,  +INF)
         1       WORKFORCE
```

TEST1
MODEL STATISTICS SOLVE TEST1 USING MIP FROM LINE 47

MODEL STATISTICS

BLOCKS OF EQUATIONS	2	SINGLE EQUATIONS	9
BLOCKS OF VARIABLES	2	SINGLE VARIABLES	9
NON ZERO ELEMENTS	25	DISCRETE VARIABLES	8

GENERATION TIME = 0.320 SECONDS

EXECUTION TIME = 0.960 SECONDS

```
TEST1
SOLUTION REPORT     SOLVE TEST1 USING MIP FROM LINE 47


               S O L V E      S U M M A R Y

     MODEL   TEST1                 OBJECTIVE  Z
     TYPE    MIP                   DIRECTION  MINIMIZE
     SOLVER  ZOOM                  FROM LINE  47

**** SOLVER STATUS     1 NORMAL COMPLETION
**** MODEL STATUS      1 OPTIMAL
**** OBJECTIVE VALUE                4.0000

 RESOURCE USAGE, LIMIT          0.340     1000.000
 ITERATION COUNT, LIMIT        12         1000

 Z O O M / X M P    ---    Version 2.1 Oct 1988

 Courtesy of Dr Roy E. Marsten,
             Department of Management Information Systems,
             University of Arizona,
             Tucson     Arizona  85721,  U.S.A.


 No options file found - using defaults.

 Work space needed (estimate)   --    1984 words.
 Work space available           --    1984 words.

 Iterations: Initial LP             12, Time: 2.999973E-02
             Heuristic               0,       0.000000E+00
             Branch and bound        0,       0.000000E+00
             Final LP                0,       0.000000E+00

                       LOWER     LEVEL     UPPER     MARGINAL

---- EQU WORKFORCE        .         .         .         1.000

  WORKFORCE   DEFINES OBJECTIVE FUNCTION


---- EQU REQUIRE     DEFINES REQUIREMENT FOR EACH SHIFT

          LOWER     LEVEL     UPPER     MARGINAL

SHIFT1     1.000     1.000     +INF        1.000
SHIFT2     1.000     1.000     +INF         EPS
SHIFT3     1.000     1.000     +INF        1.000
SHIFT4     1.000     1.000     +INF         EPS
SHIFT5     1.000     1.000     +INF        1.000
SHIFT6     1.000     1.000     +INF         EPS
SHIFT7     1.000     1.000     +INF        1.000
SHIFT8     1.000     1.000     +INF          .
```

TEST1
SOLUTION REPORT SOLVE TEST1 USING MIP FROM LINE 47

---- VAR X WILL BE 1 IF SCHEDULE J IS SELECTED

	LOWER	LEVEL	UPPER	MARGINAL
SCH1	.	1.000	1.000	.
SCH2	.	1.000	1.000	.
SCH3	.	1.000	1.000	.
SCH4	.	1.000	1.000	.
SCH5	.	.	1.000	.
SCH6	.	.	1.000	.
SCH7	.	.	1.000	EPS
SCH8	.	.	1.000	.

	LOWER	LEVEL	UPPER	MARGINAL
---- VAR Z	-INF	4.000	+INF	.

Z TOTAL SCHEDULES THAT ARE WORKED

**** REPORT SUMMARY : 0 NONOPT
0 INFEASIBLE
0 UNBOUNDED

```
TEST1
E X E C U T I N G


----     49 VARIABLE  X.L            WILL BE 1 IF SCHEDULE J IS SELECTED

SCH1 1.000,     SCH2 1.000,     SCH3 1.000,     SCH4 1.000


**** FILE SUMMARY

INPUT    GSO93D:[MIDZI.FINALTHESIS]TESTRUN.GMS;1
OUTPUT   GSO93D:[MIDZI.FINALTHESIS]TESTRUN.LIS;1

EXECUTION TIME       =        0.860 SECONDS
```

Appendix B

This Appendix contains two data tables. Table B.1 lists five-hundred schedules having 10-day cycles. Each schedule contains two day-shifts, two swing-shifts, two midnight-shifts and four off-shifts. Table B.2 lists five-hundred schedules having a 25-day cycle. Each of these schedules contains five day-shifts, five swing-shifts, five midnight-shifts and ten off-shifts.

Table B.1 is a matrix of thirty rows and five-hundred columns. During any day of a cycle there must be a minimum number of crew personnel assigned to cover each workshift period. There is a total of thirty workshift periods in a 10-day cycle. Rows *one* through *thirty* represent these workshift periods. Each column, S1 through S500, represents a shift combination. Each shift combination contains a sequence of ones and zeros. The value of the element contained in row i and column j (where $i = 1, ..., 30$ and $j = 1, ..., 500$) represents whether a workshift is assigned. A value of "one" means that workshift i is assigned in schedule j. Table B.2 is also a matrix. The only difference is that it contains seventy-five rows and five-hundred columns.

These tables were used to formulate the set covering problems for each of the three satellite crew positions. The Flight Commander and the Ground System Operator models were formulated and solved using all five-hundred schedules. However, a number of schedules had to be eliminated from the Crew Commander models because the models were too large to solve in a reasonable amount of time.

Each Crew Commander problem was modeled using all five hundred schedules. The results obtained from the solver process produced integer solutions that were not optimal. The model size was reduced by eliminating a number of shift combinations from the set of potential schedules. The shift combinations that remained in the models were selected by examining the solution to the model containing all five hundred schedules. If a shift combination was used in the solution, then it was kept in the model. In addition, shift combinations

having the same sequence of shifts but different starting days were also kept.

The number of potential schedules for the Crew Commander model with a cycle length of ten days was reduced to the two-hundred ten schedules. The shift combinations which remained in the model were S1-S100, S201-S260, S291-S300, S411-S420, S441-S450, and S461-S480. The number of potential schedules for the 25-day model was reduced by four-hundred; schedules S1-S100 were kept.

Table B.1: Schedules for a 10-Day Cycle

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	1	1	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	1	0	0	0	0	0	0	0
6	0	0	0	1	1	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	1	0	0	0	0	0	0	0	0
9	0	0	1	1	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	0	0	0	0	0	0	1
12	0	1	1	0	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	0	0	0	0	0	1	1
15	1	1	0	0	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	1	0	0	0	0	0	0	0	0	1
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	0	0	0	0	0	0	0	0	1	1
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0
24	0	0	0	0	0	0	0	1	1	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	1	0	0	0	0
27	0	0	0	0	0	0	1	1	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	0	0	0	0	0	1	1	0	0	0
+	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	1	0	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	1	1	0	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	1	1	0	0	0	0	0	0	0
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	1	0	0	0	0	0	0	0	0
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	1	0	0	0	0	0	0	0	0	1
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	0	1	1

18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	1	1	0	0
24	1	0	0	0	0	0	0	0	0	1
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	1	1	0	0	0	0
30	0	0	0	0	0	0	0	1	1	0
+	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	1	0	0
3	0	0	0	1	1	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	1	1	0	0	0
6	0	0	1	1	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	1	1	0	0	0	0
9	0	1	1	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	1	1	0	0	0	0	0
12	1	1	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	1	1	0	0	0	0	0	0
15	1	0	0	0	0	0	0	0	0	1
16	0	0	0	0	0	1	1	0	0	0
17	0	1	1	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	1	1
19	0	0	0	0	1	1	0	0	0	0
20	1	1	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	1	1	0
22	0	0	0	1	1	0	0	0	0	0
23	1	0	0	0	0	0	0	0	0	1
24	0	0	0	0	0	0	1	1	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	1	1
27	0	0	0	0	0	1	1	0	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	1	1	0
30	0	0	0	0	1	1	0	0	0	0
+	S31	S32	S33	S34	S35	S36	S37	S38	S39	S40
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	1	1	0	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	1	1	0	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	1	1	0	0	0	0	0	0
9	0	0	0	0	0	1	1	0	0	0

10	0	0	0	0	0	0	0	1	1	0
11	0	1	1	0	0	0	0	0	0	0
12	0	0	0	0	1	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	1	1	0	0	0	0	0	0	0	0
15	0	0	0	1	1	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	1	0	0	0	0	0	0	0	0	1
18	0	0	1	1	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	0	0	1	1
21	0	1	1	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	0	1	1	0
24	1	1	0	0	0	0	0	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	1	1	0	0
27	1	0	0	0	0	0	0	0	0	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	1	1	0	0	0
30	0	0	0	0	0	0	0	0	1	1
+	S41	S42	S43	S44	S45	S46	S47	S48	S49	S50
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	1	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	1	1	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	1	1	0	0	0	0	0	0	0
9	0	0	0	0	0	1	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	1	0	0	0	0	0	0	0	0
12	0	0	0	0	1	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	1	0	0	0	0	0	0	0	0	1
15	0	0	0	1	1	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	0	1	1
18	0	0	1	1	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	0	1	1	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	1	1	0	0
24	1	1	0	0	0	0	0	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	0
27	1	0	0	0	0	0	0	0	0	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	1	1	0	0	0	0
30	0	0	0	0	0	0	0	0	1	1
+	S51	S52	S53	S54	S55	S56	S57	S58	S59	S60
1	1	1	0	0	0	0	0	0	0	0

2	0	0	0	0	0	0	0	1	1	0
3	0	0	0	0	1	1	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	1	1	0	0
6	0	0	0	1	1	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	1	1	0	0	0
9	0	0	1	1	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	0	1	1	0	0	0	0
12	0	1	1	0	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	1	1	0	0	0	0	0
15	1	1	0	0	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	1	1	0	0	0	0	0	0
18	1	0	0	0	0	0	0	0	0	1
19	0	0	0	0	1	1	0	0	0	0
20	0	1	1	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	1	1
22	0	0	0	1	1	0	0	0	0	0
23	1	1	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	1	1	0
25	0	0	1	1	0	0	0	0	0	0
26	1	0	0	0	0	0	0	0	0	1
27	0	0	0	0	0	0	1	1	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	0	0	1	1	0	0	0
+	S61	S62	S63	S64	S65	S66	S67	S68	S69	S70
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	1	1	0
3	0	0	0	1	1	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	1	1	0	0
6	0	0	1	1	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	1	1	0	0	0
9	0	1	1	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	0	1	1	0	0	0	0
12	1	1	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	1	1	0	0	0	0	0
15	1	0	0	0	0	0	0	0	0	1
16	0	0	0	0	0	1	1	0	0	0
17	0	0	1	1	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	1	1
19	0	0	0	0	1	1	0	0	0	0
20	0	1	1	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	1	1	0
22	0	0	0	1	1	0	0	0	0	0
23	1	1	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	1	1.	0	0

25	0	0	1	1	0	0	0	0	0	0
26	1	0	0	0	0	0	0	0	0	1
27	0	0	0	0	0	1	1	0	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	0	1	1	0	0	0	0
+	S71	S72	S73	S74	S75	S76	S77	S78	S79	S80
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	0	1	0	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	0	1	0	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	0	1	0	0	0	0	0	0	0
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	1	0	0	0	0	0	0	0	1
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	1	0	0	0	0	0	0	0	1	0
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	1	0	1
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	0	1	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	0	1	0	0
24	1	0	0	0	0	0	0	0	0	1
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	0	1	0	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	0	1	0	0	0	0
30	0	0	0	0	0	0	0	1	1	0
+	S81	S82	S83	S84	S85	S86	S87	S88	S89	S90
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	0	0	1	0	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	0	0	1	0	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	0	0	1	0	0	0	0	0	0
9	0	0	0	0	0	1	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	1	0	0	0	0	0	0	1
12	0	0	0	0	1	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	1	0	0	0	0	0	0	1	0
15	0	0	0	1	1	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0

17	1	0	0	0	0	0	0	1	0	0
18	0	0	1	1	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	0	0	1
21	0	1	1	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	0	0	1	0
24	1	1	0	0	0	0	0	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	0	0	1	0	0
27	1	0	0	0	0	0	0	0	0	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	0	0	1	0	0	0
30	0	0	0	0	0	0	0	0	1	1
+	S91	S92	S93	S94	S95	S96	S97	S98	S99	S100
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	1	0	0	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	1	0	0	0	0	0	0	0	0
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	0	0	0	0	0	0	1
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0
24	1	0	0	0	0	0	0	0	0	1
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	1	0	0	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	0	0	0	0	0	0	0	1	1	0
+	S101	S102	S103	S104	S105	S106	S107	S108	S109	S110
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	0	1	1	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	1	0	0	0	0	0	0	0
6	0	0	0	0	1	1	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	1	0	0	0	0	0	0	0	0

9	0	0	0	1	1	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	0	0	0	0	0	0	1
12	0	0	1	1	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	1	1	0	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	1	1	0	0	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	1	0	0	0	0	0	0	0	0	1
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0
24	0	0	0	0	0	0	0	0	1	1
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	1	0	0	0	0
27	0	0	0	0	0	0	0	1	1	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	0	0	0	0	0	0	1	1	0	0
+	S111	S112	S113	S114	S115	S116	S117	S118	S119	S120
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	0	0	1	0	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	1	0	0	0	0	0	0	0
6	0	0	0	0	0	1	0	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	1	0	0	0	0	0	0	0	0
9	0	0	0	0	1	0	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	0	0	0	0	0	0	1
12	0	0	0	1	0	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	1	0	1	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	1	0	1	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	1	0	1	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0
24	0	1	0	0	0	0	0	0	0	1
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	1	0	0	0	0
27	1	0	0	0	0	0	0	0	1	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	0	0	0	0	0	0	0	1	0	1
+	S121	S122	S123	S124	S125	S126	S127	S128	S129	S130

1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	1	0	1	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	1	0	0	0	0	0	0	0
6	0	0	0	1	0	1	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	1	0	0	0	0	0	0	0	0
9	0	0	1	0	1	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	0	0	0	0	0	0	1
12	0	1	0	1	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	0	0	0	0	0	1	1
15	1	0	1	0	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	1	0	0	0	0	0	0	0	1
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	1	0	0	0	0	0	0	0	1	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0
24	0	0	0	0	0	0	0	1	0	1
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	1	0	0	0	0
27	0	0	0	0	0	0	1	0	1	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	0	0	0	0	0	1	0	1	0	0
+	S131	S132	S133	S134	S135	S136	S137	S138	S139	S140
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	1	0	0	1	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	1	0	0	0	0	0	0	0
6	0	0	0	1	0	0	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	1	0	0	0	0	0	0	0	0
9	0	0	1	0	0	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	0	0	0	0	0	0	1
12	0	1	0	0	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	0	0	0	0	0	1	1
15	1	0	0	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	0	1	0	0	0	0	0	0	1
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	0	1	0	0	0	0	0	0	1	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0

24	1	0	0	0	0	0	0	1	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	1	0	0	0	0
27	0	0	0	0	0	0	1	0	0	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	0	0	0	0	0	1	0	0	1	0
+	S141	S142	S143	S144	S145	S146	S147	S148	S149	S150
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	1	0	0	0	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	1	0	0	0	0	0	0	0
6	0	0	0	1	0	0	0	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	1	0	0	0	0	0	0	0	0
9	0	0	1	0	0	0	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	0	0	0	0	0	0	1
12	0	1	0	0	0	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	0	0	0	0	0	1	1
15	1	0	0	0	1	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	0	0	1	0	0	0	0	0	1
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	0	0	1	0	0	0	0	0	1	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0
24	0	1	0	0	0	0	0	1	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	1	0	0	0	0
27	1	0	0	0	0	0	1	0	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	0	0	0	0	0	1	0	0	0	1
+	S151	S152	S153	S154	S155	S156	S157	S158	S159	S160
1	1	0	1	0	0	0	0	0	0	0
2	0	0	0	1	1	0	0	0	0	0
3	0	0	0	0	0	1	1	0	0	0
4	0	1	0	0	0	0	0	0	0	1
5	0	0	1	1	0	0	0	0	0	0
6	0	0	0	0	1	1	0	0	0	0
7	1	0	0	0	0	0	0	0	1	0
8	0	1	1	0	0	0	0	0	0	0
9	0	0	0	1	1	0	0	0	0	0
10	0	0	0	0	0	0	0	1	0	1
11	1	1	0	0	0	0	0	0	0	0
12	0	0	1	1	0	0	0	0	0	0
13	0	0	0	0	0	0	1	0	1	0
14	1	0	0	0	0	0	0	0	0	1
15	0	1	1	0	0	0	0	0	0	0

16	0	0	0	0	0	1	0	1	0	0
17	0	0	0	0	0	0	0	0	1	1
18	1	1	0	0	0	0	0	0	0	0
19	0	0	0	0	1	0	1	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	1	0	0	0	0	0	0	0	0	1
22	0	0	0	1	0	1	0	0	0	0
23	0	0	0	0	0	0	1	1	0	0
24	0	0	0	0	0	0	0	0	1	1
25	0	0	1	0	1	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	0
27	0	0	0	0	0	0	0	1	1	0
28	0	1	0	1	0	0	0	0	0	0
29	0	0	0	0	1	1	0	0	0	0
30	0	0	0	0	0	0	1	1	0	0
+	S161	S162	S163	S164	S165	S166	S167	S168	S169	S170
1	1	0	1	0	0	0	0	0	0	0
2	0	0	0	0	1	1	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	0	1	0	0	0	0	0	0	0	1
5	0	0	0	1	1	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	0
7	1	0	0	0	0	0	0	0	1	0
8	0	0	1	1	0	0	0	0	0	0
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	0	1
11	0	1	1	0	0	0	0	0	0	0
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	0	1	0
14	1	1	0	0	0	0	0	0	0	0
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	0	1	0	0
17	1	0	0	0	0	0	0	0	0	1
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	0	1	0	0	0
20	0	0	0	0	0	0	0	0	1	1
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	0	1	0	0	0	0
23	0	0	0	0	0	0	0	1	1	0
24	1	0	0	0	0	0	0	0	0	1
25	0	0	1	0	1	0	0	0	0	0
26	0	0	0	0	0	0	1	1	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	1	0	1	0	0	0	0	0	0
29	0	0	0	0	0	1	1	0	0	0
30	0	0	0	0	0	0	0	1	1	0
+	S171	S172	S173	S174	S175	S176	S177	S178	S179	S180
1	1	0	1	0	0	0	0	0	0	0
2	0	0	0	0	0	1	1	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	0	1	0	0	0	0	0	0	0	1
5	0	0	0	0	1	1	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	1	0	0	0	0	0	0	0	1	0

8	0	0	0	1	1	0	0	0	0	0
9	0	0	0	0	0	1	1	0	0	0
10	0	0	0	0	0	0	0	1	0	1
11	0	0	1	1	0	0	0	0	0	0
12	0	0	0	0	1	1	0	0	0	0
13	0	0	0	0	0	0	1	0	1	0
14	0	1	1	0	0	0	0	0	0	0
15	0	0	0	1	1	0	0	0	0	0
16	0	0	0	0	0	1	0	1	0	0
17	1	1	0	0	0	0	0	0	0	0
18	0	0	1	1	0	0	0	0	0	0
19	0	0	0	0	1	0	1	0	0	0
20	1	0	0	0	0	0	0	0	0	1
21	0	1	1	0	0	0	0	0	0	0
22	0	0	0	1	0	1	0	0	0	0
23	0	0	0	0	0	0	0	0	1	1
24	1	1	0	0	0	0	0	0	0	0
25	0	0	1	0	1	0	0	0	0	0
26	0	0	0	0	0	0	0	1	1	0
27	1	0	0	0	0	0	0	0	0	1
28	0	1	0	1	0	0	0	0	0	0
29	0	0	0	0	0	0	1	1	0	0
30	0	0	0	0	0	0	0	0	1	1
+	S181	S182	S183	S184	S185	S186	S187	S188	S189	S190
1	1	0	1	0	0	0	0	0	0	0
2	0	0	0	1	0	1	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	0	1	0	0	0	0	0	0	0	1
5	0	0	1	0	1	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	0
7	1	0	0	0	0	0	0	0	1	0
8	0	1	0	1	0	0	0	0	0	0
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	0	1
11	1	0	1	0	0	0	0	0	0	0
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	0	1	0
14	0	1	0	0	0	0	0	0	0	1
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	0	1	0	0
17	1	0	0	0	0	0	0	0	1	0
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	0	1	0	0	0
20	0	0	0	0	0	0	0	1	0	1
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	0	1	0	0	0	0
23	0	0	0	0	0	0	1	0	1	0
24	1	0	0	0	0	0	0	0	0	1
25	0	0	1	0	1	0	0	0	0	0
26	0	0	0	0	0	1	0	1	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	1	0	1	0	0	0	0	0	0
29	0	0	0	0	1	0	1	0	0	0
30	0	0	0	0	0	0	0	1	1	0

+	S191	S192	S193	S194	S195	S196	S197	S198	S199	S200
1	1	0	1	0	0	0	0	0	0	0
2	0	0	0	1	1	0	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	0	1	0	0	0	0	0	0	0	1
5	0	0	1	1	0	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	0
7	1	0	0	0	0	0	0	0	1	0
8	0	1	1	0	0	0	0	0	0	0
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	0	1
11	1	1	0	0	0	0	0	0	0	0
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	0	1	0
14	1	0	0	0	0	0	0	0	0	1
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	0	1	0	0
17	0	0	0	0	0	0	0	0	1	1
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	0	1	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	0	1	0	0	0	0
23	0	0	0	0	0	0	1	1	0	0
24	1	0	0	0	0	0	0	0	0	1
25	0	0	1	0	1	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	1	0	1	0	0	0	0	0	0
29	0	0	0	0	1	1	0	0	0	0
30	0	0	0	0	0	0	0	1	1	0
+	S201	S202	S203	S204	S205	S206	S207	S208	S209	S210
1	1	0	1	0	0	0	0	0	0	0
2	0	0	0	1	1	0	0	0	0	0
3	0	0	0	0	0	1	0	1	0	0
4	0	1	0	0	0	0	0	0	0	1
5	0	0	1	1	0	0	0	0	0	0
6	0	0	0	0	1	0	1	0	0	0
7	1	0	0	0	0	0	0	0	1	0
8	0	1	1	0	0	0	0	0	0	0
9	0	0	0	1	0	1	0	0	0	0
10	0	0	0	0	0	0	0	1	0	1
11	1	1	0	0	0	0	0	0	0	0
12	0	0	1	0	1	0	0	0	0	0
13	0	0	0	0	0	0	1	0	1	0
14	1	0	0	0	0	0	0	0	0	1
15	0	1	0	1	0	0	0	0	0	0
16	0	0	0	0	0	1	0	1	0	0
17	0	0	0	0	0	0	0	0	1	1
18	1	0	1	0	0	0	0	0	0	0
19	0	0	0	0	1	0	1	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	0	1	0	0	0	0	0	0	0	1
22	0	0	0	1	0	1	0	0	0	0

23	0	0	0	0	0	0	1	1	0	0
24	1	0	0	0	0	0	0	0	1	0
25	0	0	1	0	1	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	0
27	0	0	0	0	0	0	0	1	0	1
28	0	1	0	1	0	0	0	0	0	0
29	0	0	0	0	1	1	0	0	0	0
30	0	0	0	0	0	0	1	0	1	0
+	S211	S212	S213	S214	S215	S216	S217	S218	S219	S220
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	1	1	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	1	1	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	1	1	0	0	0	0	0
9	0	0	0	0	0	1	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	1	1	0	0	0	0	0	0
12	0	0	0	0	1	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	1	1	0	0	0	0	0	0	0
15	0	0	0	1	1	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	1	1	0	0	0	0	0	0	0	0
18	0	0	1	1	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	1	0	0	0	0	0	0	0	0	1
21	0	1	1	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	0	0	1	1
24	1	1	0	0	0	0	0	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	0	1	1	0
27	1	0	0	0	0	0	0	0	0	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	1	1	0	0
30	0	0	0	0	0	0	0	0	1	1
+	S221	S222	S223	S224	S225	S226	S227	S228	S229	S230
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	1	0	0	0	0	0
3	0	0	0	0	0	1	0	1	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	1	1	0	0	0	0	0	0
6	0	0	0	0	1	0	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	1	1	0	0	0	0	0	0	0
9	0	0	0	1	0	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	1	0	0	0	0	0	0	0	0
12	0	0	1	0	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0

14	1	0	0	0	0	0	0	0	0	1
15	0	1	0	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	0	1	1
18	1	0	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	0	1	0	0	0	0	0	0	0	1
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	1	1	0	0
24	1	0	0	0	0	0	0	0	1	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	0
27	0	0	0	0	0	0	0	1	0	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	1	1	0	0	0	0
30	0	0	0	0	0	0	1	0	1	0
+	S231	S232	S233	S234	S235	S236	S237	S238	S239	S240
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	1	0	0	0	0	0
3	0	0	0	0	0	1	1	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	1	1	0	0	0	0	0	0
6	0	0	0	0	1	1	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	1	1	0	0	0	0	0	0	0
9	0	0	0	1	1	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	1	0	0	0	0	0	0	0	0
12	0	0	1	1	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	1	0	0	0	0	0	0	0	0	1
15	0	1	1	0	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	0	1	1
18	1	1	0	0	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	1	0	0	0	0	0	0	0	0	1
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	1	1	0	0
24	0	0	0	0	0	0	0	0	1	1
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	0
27	0	0	0	0	0	0	0	1	1	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	1	1	0	0	0	0
30	0	0	0	0	0	0	1	1	0	0
+	S241	S242	S243	S244	S245	S246	S247	S248	S249	S250
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	1	1	0
3	0	0	0	0	1	1	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	1	1	0	0

6	0	0	0	1	1	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	1	1	0	0	0
9	0	0	1	1	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	0	1	1	0	0	0	0
12	0	1	1	0	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	1	1	0	0	0	0	0
15	1	1	0	0	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	1	1	0	0	0	0	0	0
18	1	0	0	0	0	0	0	0	0	1
19	0	0	0	0	1	1	0	0	0	0
20	0	1	1	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	1	1
22	0	0	0	1	1	0	0	0	0	0
23	1	1	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	1	1	0
25	0	0	1	1	0	0	0	0	0	0
26	1	0	0	0	0	0	0	0	0	1
27	0	0	0	0	0	0	1	1	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	0	0	1	1	0	0	0
+	S251	S252	S253	S254	S255	S256	S257	S258	S259	S260
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	0	1	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	1	0	1	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	1	0	1	0	0	0	0	0	0
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	1	0	0	0	0	0	0	0
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	1	0	0	0	0	0	0	0	1
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	1	0	0	0	0	0	0	0	1	0
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	0	1	0	1
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	1	0	1	0
24	1	0	0	0	0	0	0	0	0	1
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	1	0	1	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	1	1	0	0	0	0	0	0	0

29	0	0	0	0	1	0	1	0	0	0
30	0	0	0	0	0	0	0	1	1	0
+	S261	S262	S263	S264	S265	S266	S267	S268	S269	S270
1	1	0	0	0	1	0	0	0	0	0
2	0	1	0	0	0	1	0	0	0	0
3	0	0	1	0	0	0	1	0	0	0
4	0	0	0	1	0	0	0	0	0	1
5	1	0	0	0	1	0	0	0	0	0
6	0	1	0	0	0	1	0	0	0	0
7	0	0	1	0	0	0	0	0	1	0
8	0	0	0	1	0	0	0	0	0	1
9	1	0	0	0	1	0	0	0	0	0
10	0	1	0	0	0	0	0	1	0	0
11	0	0	1	0	0	0	0	0	1	0
12	0	0	0	1	0	0	0	0	0	1
13	1	0	0	0	0	0	1	0	0	0
14	0	1	0	0	0	0	0	1	0	0
15	0	0	1	0	0	0	0	0	1	0
16	0	0	0	0	0	1	0	0	0	1
17	1	0	0	0	0	0	1	0	0	0
18	0	1	0	0	0	0	0	1	0	0
19	0	0	0	0	1	0	0	0	1	0
20	0	0	0	0	0	1	0	0	0	1
21	1	0	0	0	0	0	1	0	0	0
22	0	0	0	1	0	0	0	1	0	0
23	0	0	0	0	1	0	0	0	1	0
24	0	0	0	0	0	1	0	0	0	1
25	0	0	1	0	0	0	1	0	0	0
26	0	0	0	1	0	0	0	1	0	0
27	0	0	0	0	1	0	0	0	1	0
28	0	1	0	0	0	1	0	0	0	0
29	0	0	1	0	0	0	1	0	0	0
30	0	0	0	1	0	0	0	1	0	0
+	S271	S272	S273	S274	S275	S276	S277	S278	S279	S280
1	1	0	0	0	0	1	0	0	0	0
2	0	1	0	0	0	0	0	0	1	0
3	0	0	1	0	0	0	1	0	0	0
4	0	0	0	0	1	0	0	0	0	1
5	1	0	0	0	0	0	0	1	0	0
6	0	1	0	0	0	1	0	0	0	0
7	0	0	0	1	0	0	0	0	1	0
8	0	0	0	0	1	0	1	0	0	0
9	1	0	0	0	0	0	0	0	0	1
10	0	0	1	0	0	0	0	1	0	0
11	0	0	0	1	0	1	0	0	0	0
12	0	0	0	0	1	0	0	0	1	0
13	0	1	0	0	0	0	1	0	0	0
14	0	0	1	0	0	0	0	0	0	1
15	0	0	0	1	0	0	0	1	0	0
16	1	0	0	0	0	1	0	0	0	0
17	0	1	0	0	0	0	0	0	1	0
18	0	0	1	0	0	0	1	0	0	0
19	0	0	0	0	1	0	0	0	0	1
20	1	0	0	0	0	0	0	1	0	0

21	0	1	0	0	0	1	0	0	0	0
22	0	0	0	1	0	0	0	0	1	0
23	0	0	0	0	1	0	1	0	0	0
24	1	0	0	0	0	0	0	0	0	1
25	0	0	1	0	0	0	0	1	0	0
26	0	0	0	1	0	1	0	0	0	0
27	0	0	0	0	1	0	0	0	1	0
28	0	1	0	0	0	0	1	0	0	0
29	0	0	1	0	0	0	0	0	0	1
30	0	0	0	1	0	0	0	1	0	0
+	S281	S282	S283	S284	S285	S286	S287	S288	S289	S290
1	1	0	0	0	0	0	1	0	0	0
2	0	0	0	1	1	0	0	0	0	0
3	0	1	0	0	0	0	0	1	0	0
4	0	0	0	0	0	1	0	0	0	1
5	0	0	1	1	0	0	0	0	0	0
6	1	0	0	0	0	0	1	0	0	0
7	0	0	0	0	1	0	0	0	1	0
8	0	1	1	0	0	0	0	0	0	0
9	0	0	0	0	0	1	0	0	0	1
10	0	0	0	1	0	0	0	1	0	0
11	1	1	0	0	0	0	0	0	0	0
12	0	0	0	0	1	0	0	0	1	0
13	0	0	1	0	0	0	1	0	0	0
14	1	0	0	0	0	0	0	0	0	1
15	0	0	0	1	0	0	0	1	0	0
16	0	1	0	0	0	1	0	0	0	0
17	0	0	0	0	0	0	0	0	1	1
18	0	0	1	0	0	0	1	0	0	0
19	1	0	0	0	1	0	0	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	0	1	0	0	0	1	0	0	0	0
22	0	0	0	1	0	0	0	0	0	1
23	0	0	0	0	0	0	1	1	0	0
24	1	0	0	0	1	0	0	0	0	0
25	0	0	1	0	0	0	0	0	1	0
26	0	0	0	0	0	1	1	0	0	0
27	0	0	0	1	0	0	0	0	0	1
28	0	1	0	0	0	0	0	1	0	0
29	0	0	0	0	1	1	0	0	0	0
30	0	0	1	0	0	0	0	0	1	0
+	S291	S292	S293	S294	S295	S296	S297	S298	S299	S300
1	1	0	0	0	0	0	0	1	0	0
2	0	0	0	1	1	0	0	0	0	0
3	0	1	0	0	0	0	0	0	1	0
4	0	0	0	0	0	0	1	0	0	1
5	0	0	1	1	0	0	0	0	0	0
6	1	0	0	0	0	0	0	1	0	0
7	0	0	0	0	0	1	0	0	1	0
8	0	1	1	0	0	0	0	0	0	0
9	0	0	0	0	0	0	1	0	0	1
10	0	0	0	0	1	0	0	1	0	0
11	1	1	0	0	0	0	0	0	0	0
12	0	0	0	0	0	1	0	0	1	0

13	0	0	0	1	0	0	1	0	0	0
14	1	0	0	0	0	0	0	0	0	1
15	0	0	0	0	1	0	0	1	0	0
16	0	0	1	0	0	1	0	0	0	0
17	0	0	0	0	0	0	0	0	1	1
18	0	0	0	1	0	0	1	0	0	0
19	0	1	0	0	1	0	0	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	0	0	1	0	0	1	0	0	0	0
22	1	0	0	1	0	0	0	0	0	0
23	0	0	0	0	0	0	1	1	0	0
24	0	1	0	0	1	0	0	0	0	0
25	0	0	1	0	0	0	0	0	0	1
26	0	0	0	0	0	1	1	0	0	0
27	1	0	0	1	0	0	0	0	0	0
28	0	1	0	0	0	0	0	0	1	0
29	0	0	0	0	1	1	0	0	0	0
30	0	0	1	0	0	0	0	0	0	1
+	S301	S302	S303	S304	S305	S306	S307	S308	S309	S310
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	1	0	0	1	0
3	0	0	0	1	0	0	1	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	1	0	0	1	0	0
6	0	0	1	0	0	1	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	1	0	0	1	0	0	0
9	0	1	0	0	1	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	1	0	0	1	0	0	0	0
12	1	0	0	1	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	1	0	0	1	0	0	0	0	0
15	0	0	1	0	0	0	0	0	0	1
16	0	0	0	0	0	1	1	0	0	0
17	1	0	0	1	0	0	0	0	0	0
18	0	1	0	0	0	0	0	0	1	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	1	0	0	0	0	0	0	1
21	1	0	0	0	0	0	0	1	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	1	0	0	0	0	0	0	-	0
24	0	0	0	0	0	0	1	0	0	1
25	0	0	1	1	0	0	0	0	0	0
26	1	0	0	0	0	0	0	1	0	0
27	0	0	0	0	0	1	0	0	1	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	1	0	0	1
30	0	0	0	0	1	0	0	1	0	0
+	S311	S312	S313	S314	S315	S316	S317	S318	S319	S320
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	0	0	0	0	1	0
3	0	0	0	0	0	1	1	0	0	0
4	1	0	0	0	0	0	0	0	0	1

5	0	0	1	0	0	0	0	1	0	0
6	0	0	0	0	1	1	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	1	0	0	0	0	1	0	0	0
9	0	0	0	1	1	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	0	0	1	0	0	0	0
12	0	0	1	1	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	0	1	0	0	0	0	1
15	0	1	1	0	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	1	0	0	0	0	1	0
18	1	1	0	0	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	1	0	0	0	0	1	0	0
21	1	0	0	0	0	0	0	0	0	1
22	0	0	0	1	1	0	0	0	0	0
23	0	1	0	0	0	0	1	0	0	0
24	0	0	0	0	0	0	0	0	1	1
25	0	0	1	1	0	0	0	0	0	0
26	1	0	0	0	0	1	0	0	0	0
27	0	0	0	0	0	0	0	1	1	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	1	0	0	0	0	1
30	0	0	0	0	0	0	1	1	0	0
+	S321	S322	S323	S324	S325	S326	S327	S328	S329	S330
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	1	1	0
3	0	0	1	1	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	1	1	0	0
6	0	1	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	1	1	0	0	0
9	1	1	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	0	1	1	0	0	0	0
12	1	0	0	0	0	0	0	0	0	1
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	1	1	0	0	0	0	0
15	0	0	0	0	0	0	0	0	1	1
16	0	0	0	0	0	1	1	0	0	0
17	0	0	1	1	0	0	0	0	0	0
18	0	0	0	0	0	0	0	1	1	0
19	0	0	0	0	1	1	0	0	0	0
20	0	1	1	0	0	0	0	0	0	0
21	0	0	0	0	0	0	1	1	0	0
22	0	0	0	1	1	0	0	0	0	0
23	1	1	0	0	0	0	0	0	0	0
24	0	0	0	0	0	1	1	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	1	0	0	0	0	0	0	0	0	1
27	0	0	0	0	1	1	0	0	0	0

28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	1	1	0	0	0	0	0
+	S331	S332	S333	S334	S335	S336	S337	S338	S339	S340
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	1	1	0
3	0	0	1	0	0	1	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	1	1	0	0
6	0	1	0	0	1	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	1	1	0	0	0
9	1	0	0	1	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	0	1	1	0	0	0	0
12	0	0	1	0	0	0	0	0	0	1
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	1	1	0	0	0	0	0
15	0	1	0	0	0	0	0	0	1	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	1	1	0	0	0	0	0	0
18	1	0	0	0	0	0	0	1	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	1	1	0	0	0	0	0	0	0
21	0	0	0	0	0	0	1	0	0	1
22	0	0	0	1	1	0	0	0	0	0
23	1	1	0	0	0	0	0	0	0	0
24	0	0	0	0	0	1	0	0	1	0
25	0	0	1	1	0	0	0	0	0	0
26	1	0	0	0	0	0	0	0	0	1
27	0	0	0	0	1	0	0	1	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	1	0	0	1	0	0	0
+	S341	S342	S343	S344	S345	S346	S347	S348	S349	S350
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	0	0	0	0	1	0
3	0	0	0	0	1	1	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	1	0	0	0	0	1	0	0
6	0	0	0	1	1	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	1	0	0	0	0	1	0	0	0
9	0	0	1	1	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	0	0	1	0	0	0	0
12	0	1	1	0	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	0	1	0	0	0	0	1
15	1	1	0	0	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	1	0	0	0	0	1	0
18	1	0	0	0	0	0	0	0	0	1
19	0	0	0	0	1	1	0	0	0	0

20	0	0	1	0	0	0	0	1	0	0
21	0	0	0	0	0	0	0	0	1	1
22	0	0	0	1	1	0	0	0	0	0
23	0	1	0	0	0	0	1	0	0	0
24	0	0	0	0	0	0	0	1	1	0
25	0	0	1	1	0	0	0	0	0	0
26	1	0	0	0	0	1	0	0	0	0
27	0	0	0	0	0	0	1	1	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	1	0	0	0	0	1
30	0	0	0	0	0	1	1	0	0	0
+	S351	S352	S353	S354	S355	S356	S357	S358	S359	S360
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	1	0	0	1	0
3	0	0	1	1	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	1	0	0	1	0	0
6	0	1	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	1	0	0	1	0	0	0
9	1	1	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	1	0	0	1	0	0	0	0
12	1	0	0	0	0	0	0	0	0	1
13	0	0	0	0	0	0	1	1	0	0
14	0	1	0	0	1	0	0	0	0	0
15	0	0	0	0	0	0	0	0	1	1
16	0	0	0	0	0	1	1	0	0	0
17	1	0	0	1	0	0	0	0	0	0
18	0	0	0	0	0	0	0	1	1	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	1	0	0	0	0	0	0	1
21	0	0	0	0	0	0	1	1	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	1	0	0	0	0	0	0	1	0
24	0	0	0	0	0	1	1	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	1	0	0	0	0	0	0	1	0	0
27	0	0	0	0	1	1	0	0	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	1	0	0	1
30	0	0	0	1	1	0	0	0	0	0
+	S361	S362	S363	S364	S365	S366	S367	S368	S369	S370
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	1	0	0
3	0	0	0	1	0	0	0	0	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	1	1	0	0	0
6	0	0	1	0	0	0	0	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	1	1	0	0	0	0
9	0	1	0	0	0	0	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	1	1	0	0	0	0	0

12	1	0	0	0	0	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	1	1	0	0	0	0	0	0
15	0	0	0	0	1	0	0	0	0	1
16	0	0	0	0	0	1	1	0	0	0
17	0	1	1	0	0	0	0	0	0	0
18	0	0	0	1	0	0	0	0	1	0
19	0	0	0	0	1	1	0	0	0	0
20	1	1	0	0	0	0	0	0	0	0
21	0	0	1	0	0	0	0	1	0	0
22	0	0	0	1	1	0	0	0	0	0
23	1	0	0	0	0	0	0	0	0	1
24	0	1	0	0	0	0	1	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	1	1
27	1	0	0	0	0	1	0	0	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	1	1	0
30	0	0	0	0	1	0	0	0	0	1
+	S371	S372	S373	S374	S375	S376	S377	S378	S379	S380
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	0	0	1	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	1	0	0	1	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	1	0	0	1	0	0	0	0	0
9	0	0	0	0	0	1	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	1	0	0	0	0	0	0
12	0	0	0	0	1	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	1	0	0	0	0	0	0	1
15	0	0	0	1	1	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	1	0	0	0	0	0	0	1	0
18	0	0	1	1	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	1	0	0	0	0	0	0	1	0	0
21	0	1	1	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	1	0	0	1
24	1	1	0	0	0	0	0	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	1	0	0	1	0
27	1	0	0	0	0	0	0	0	0	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	1	0	0	1	0	0
30	0	0	0	0	0	0	0	0	1	1
+	S381	S382	S383	S384	S385	S386	S387	S388	S389	S390
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	1	1	0	0	0
3	0	0	0	1	0	0	0	0	1	0

4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	1	1	0	0	0	0
6	0	0	1	0	0	0	0	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	1	1	0	0	0	0	0
9	0	1	0	0	0	0	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	1	1	0	0	0	0	0	0
12	1	0	0	0	0	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	1	1	0	0	0	0	0	0	0
15	0	0	0	0	1	0	0	0	0	1
16	0	0	0	0	0	1	1	0	0	0
17	1	1	0	0	0	0	0	0	0	0
18	0	0	0	1	0	0	0	0	1	0
19	0	0	0	0	1	1	0	0	0	0
20	1	0	0	0	0	0	0	0	0	1
21	0	0	1	0	0	0	0	1	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	0	0	1	1
24	0	1	0	0	0	0	1	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	0	1	1	0
27	1	0	0	0	0	1	0	0	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	1	1	0	0
30	0	0	0	0	1	0	0	0	0	1
+	S391	S392	S393	S394	S395	S396	S397	S398	S399	S400
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	1	0	0	1	0	0
3	0	0	0	0	0	1	0	0	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	1	0	0	1	0	0	0
6	0	0	0	0	1	0	0	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	1	0	0	1	0	0	0	0
9	0	0	0	1	0	0	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	1	0	0	1	0	0	0	0	0
12	0	0	1	0	0	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	1	0	0	1	0	0	0	0	0	0
15	0	1	0	0	1	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	1	0	0	0	0	0	0	1
18	1	0	0	1	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	1	0	0	0	0	0	0	1	0
21	0	0	1	0	0	0	0	0	0	1
22	0	0	0	1	1	0	0	0	0	0
23	1	0	0	0	0	0	0	1	0	0
24	0	1	0	0	0	0	0	0	1	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	1	0	0	1

27	1	0	0	0	0	0	0	1	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	1	0	0	1	0
30	0	0	0	0	0	0	1	0	0	1
+	S401	S402	S403	S404	S405	S406	S407	S408	S409	S410
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0	1	0	0
3	0	0	0	0	0	1	0	0	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	0	0	0	0	1	0	0	0
6	0	0	0	0	1	0	0	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	0	0	0	0	1	0	0	0	0
9	0	0	0	1	0	0	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	0	1	0	0	0	0	1
12	0	0	1	0	0	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	1	0	0	0	0	1	0
15	0	1	0	0	1	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	1	0	0	0	0	1	0	0
18	1	0	0	1	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	1	0	0	0	0	1	0	0	0
21	0	0	1	0	0	0	0	0	0	1
22	0	0	0	1	1	0	0	0	0	0
23	1	0	0	0	0	1	0	0	0	0
24	0	1	0	0	0	0	0	0	1	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	0	0	0	0	1
27	1	0	0	0	0	0	0	1	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	0	0	0	0	1	0
30	0	0	0	0	0	0	1	0	0	1
+	S411	S412	S413	S414	S415	S416	S417	S418	S419	S420
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0	1	0	0
3	0	0	0	1	0	0	0	0	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	0	0	0	0	1	0	0	0
6	0	0	1	0	0	0	0	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	0	0	0	0	1	0	0	0	0
9	0	1	0	0	0	0	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	0	1	0	0	0	0	1
12	1	0	0	0	0	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	1	0	0	0	0	1	0
15	0	0	0	0	1	0	0	0	0	1
16	0	0	0	0	0	1	1	0	0	0
17	0	0	1	0	0	0	0	1	0	0
18	0	0	0	1	0	0	0	0	1	0
19	0	0	0	0	1	1	0	0	0	0

20	0	1	0	0	0	0	1	0	0	0
21	0	0	1	0	0	0	0	1	0	0
22	0	0	0	1	1	0	0	0	0	0
23	1	0	0	0	0	1	0	0	0	0
24	0	1	0	0	0	0	1	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	0	0	0	0	1
27	1	0	0	0	0	1	0	0	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	0	0	0	0	1	0
30	0	0	0	0	1	0	0	0	0	1
+	S421	S422	S423	S424	S425	S426	S427	S428	S429	S430
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	1	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	1	0	0	0	0	0	0	0	0
9	0	0	0	0	0	1	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	0	0	0	0	0	0	1
12	0	0	0	0	1	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	0	1	1	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	0	1	1	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	0	1	1	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0
24	1	1	0	0	0	0	0	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	1	0	0	0	0
27	1	0	0	0	0	0	0	0	0	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	0	0	0	0	0	0	0	0	1	1
+	S431	S432	S433	S434	S435	S436	S437	S438	S439	S440
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	0	0	1	0	0	0	0
3	0	0	0	1	0	0	0	0	1	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	0	0	1	0	0	0	0	0
6	0	0	1	0	0	0	0	1	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	0	0	1	0	0	0	0	0	0
9	0	1	0	0	0	0	1	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	1	0	0	0	0	0	0	1

12	1	0	0	0	0	1	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	1	0	0	0	0	0	0	1	0
15	0	0	0	0	1	0	0	0	0	1
16	0	0	0	0	0	1	1	0	0	0
17	1	0	0	0	0	0	0	1	0	0
18	0	0	0	1	0	0	0	0	1	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	1	0	0	1
21	0	0	1	0	0	0	0	1	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	1	0	0	1	0
24	0	1	0	0	0	0	1	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	0	0	1	0	0
27	1	0	0	0	0	1	0	0	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	0	0	1	0	0	0
30	0	0	0	0	1	0	0	0	0	1
+	S441	S442	S443	S444	S445	S446	S447	S448	S449	S450
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	1	0	0
3	0	0	1	1	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	1	1	0	0	0
6	0	1	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	1	1	0	0	0	0
9	1	1	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	1	1	0	0	0	0	0
12	1	0	0	0	0	0	0	0	0	1
13	0	0	0	0	0	0	1	1	0	0
14	0	0	1	1	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	1	1
16	0	0	0	0	0	1	1	0	0	0
17	0	1	1	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	1	1	0
19	0	0	0	0	1	1	0	0	0	0
20	1	1	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	1	1	0	0
22	0	0	0	1	1	0	0	0	0	0
23	1	0	0	0	0	0	0	0	0	1
24	0	0	0	0	0	1	1	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	1	1
27	0	0	0	0	1	1	0	0	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	1	1	0
30	0	0	0	1	1	0	0	0	0	0
+	S451	S452	S453	S454	S455	S456	S457	S458	S459	S460
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	1	1	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0

4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	1	1	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	1	1	0	0	0	0	0	0
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	1	1	0	0	0	0	0	0	0
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	1	1	0	0	0	0	0	0	0	0
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	1	0	0	0	0	0	0	0	0	1
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	0	0	0	0
20	0	0	0	0	0	0	0	0	1	1
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	0	1	1	0
24	1	0	0	0	0	0	0	0	0	1
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	1	1	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	1	1	0	0	0
30	0	0	0	0	0	0	0	1	1	0
+	S461	S462	S463	S464	S465	S466	S467	S468	S469	S470
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	0	0	1	0	0	0
3	0	0	0	0	1	0	0	1	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	1	0	0	1	0	0	0	0
6	0	0	0	1	0	0	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	1	0	0	1	0	0	0	0	0
9	0	0	1	0	0	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	1	0	0	1	0	0	0	0	0	0
12	0	1	0	0	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	1	0	0	0	0	0	0	1
15	1	0	0	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	0	0	0
17	0	1	0	0	0	0	0	0	1	0
18	0	0	1	0	0	0	0	0	0	1
19	0	0	0	0	1	1	0	0	0	0
20	1	0	0	0	0	0	0	1	0	0
21	0	1	0	0	0	0	0	0	1	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	1	0	0	1
24	1	0	0	0	0	0	0	1	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	1	0	0	1	0

27	0	0	0	0	0	0	1	0	0	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	1	0	0	1	0	0
30	0	0	0	0	0	1	0	0	1	0
+	S471	S472	S473	S474	S475	S476	S477	S478	S479	S480
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	1	1	0	0	0
3	0	0	1	0	0	0	0	1	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	0	1	1	0	0	0	0
6	0	1	0	0	0	0	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	1	1	0	0	0	0	0
9	1	0	0	0	0	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	1	1	0	0	0	0	0	0
12	0	0	0	0	1	0	0	0	0	1
13	0	0	0	0	0	0	1	1	0	0
14	0	1	1	0	0	0	0	0	0	0
15	0	0	0	1	0	0	0	0	1	0
16	0	0	0	0	0	1	1	0	0	0
17	1	1	0	0	0	0	0	0	0	0
18	0	0	1	0	0	0	0	1	0	0
19	0	0	0	0	1	1	0	0	0	0
20	1	0	0	0	0	0	0	0	0	1
21	0	1	0	0	0	0	1	0	0	0
22	0	0	0	1	1	0	0	0	0	0
23	0	0	0	0	0	0	0	0	1	1
24	1	0	0	0	0	1	0	0	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	0	1	1	0
27	0	0	0	0	1	0	0	0	0	1
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	1	1	0	0
30	0	0	0	1	0	0	0	0	1	0
+	S481	S482	S483	S484	S485	S486	S487	S488	S489	S490
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	0	1	0	0	1	0	0
3	0	0	1	0	0	1	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	0	0	1	0	0	1	0	0	0
6	0	1	0	0	1	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	1	0	0	1	0	0	0	0
9	1	0	0	1	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	1	0	0	1	0	0	0	0	0
12	0	0	1	0	0	0	0	0	0	1
13	0	0	0	0	0	0	1	1	0	0
14	1	0	0	1	0	0	0	0	0	0
15	0	1	0	0	0	0	0	0	1	0
16	0	0	0	0	0	1	1	0	0	0
17	0	0	1	0	0	0	0	0	0	1
18	1	0	0	0	0	0	0	1	0	0
19	0	0	0	0	1	1	0	0	0	0

20	0	1	0	0	0	0	0	0	1	0
21	0	0	0	0	0	0	1	0	0	1
22	0	0	0	1	1	0	0	0	0	0
23	1	0	0	0	0	0	0	1	0	0
24	0	0	0	0	0	1	0	0	1	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	0	0	1	0	0	1
27	0	0	0	0	1	0	0	1	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	0	0	1	0	0	1	0
30	0	0	0	1	0	0	1	0	0	0
+	S491	S492	S493	S494	S495	S496	S497	S498	S499	S500
1	1	1	0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0	1	0	0
3	0	0	0	1	1	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	1
5	0	1	0	0	0	0	1	0	0	0
6	0	0	1	1	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	0	0	0	0	1	0	0	0	0
9	0	1	1	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	0
11	0	0	0	0	1	0	0	0	0	1
12	1	1	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	0	0
14	0	0	0	1	0	0	0	0	1	0
15	1	0	0	0	0	0	0	0	0	1
16	0	0	0	0	0	1	1	0	0	0
17	0	0	1	0	0	0	0	1	0	0
18	0	0	0	0	0	0	0	0	1	1
19	0	0	0	0	1	1	0	0	0	0
20	0	1	0	0	0	0	1	0	0	0
21	0	0	0	0	0	0	0	1	1	0
22	0	0	0	1	1	0	0	0	0	0
23	1	0	0	0	0	1	0	0	0	0
24	0	0	0	0	0	0	1	1	0	0
25	0	0	1	1	0	0	0	0	0	0
26	0	0	0	0	1	0	0	0	0	1
27	0	0	0	0	0	1	1	0	0	0
28	0	1	1	0	0	0	0	0	0	0
29	0	0	0	1	0	0	0	0	1	0
30	0	0	0	0	1	1	0	0	0	0 ;

Table B.2: Schedules for a 25-Day Cycle

	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
1	1	1	1	1	1	0	0	0	0	0
2	0	0	0	0	0	0	0	0	1	1
3	0	0	0	0	0	0	0	0	0	0
4	1	1	1	1	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1	1	1
6	0	0	0	0	0	0	0	0	0	0
7	1	1	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	1	1	1	1
9	0	0	0	0	0	0	0	0	0	0
10	1	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	1	1	1	1	1
12	0	0	0	0	0	0	0	0	0	0
13	1	0	0	0	0	0	0	0	0	0
14	0	0	0	0	1	1	1	1	1	0
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	1	1	1	1	1	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	1	1	1	1	1	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	1	1	1	1	1	0	0	0	0
24	0	0	0	0	0	0	0	0	0	1
25	0	0	0	0	0	0	0	0	0	0
26	1	1	1	1	1	0	0	0	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	0	0	0	0	0	0	0	0	0
29	1	1	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	0	1	1	1
31	0	0	0	0	0	0	0	0	0	0
32	1	1	1	0	0	0	0	0	0	0
33	0	0	0	0	0	0	1	1	1	1
34	0	0	0	0	0	0	0	0	0	0
35	1	1	0	0	0	0	0	0	0	0
36	0	0	0	0	0	1	1	1	1	1
37	0	0	0	0	0	0	0	0	0	0
38	1	0	0	0	0	0	0	0	0	0
39	0	0	0	0	1	1	1	1	1	0
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	1	1	1	1	1	0	0
43	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	1	1	1	1	1	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	1	1	1	1	1	0	0	0	0

49	0	0	0	0	0	0	0	0	0	1
50	0	0	0	0	0	0	0	0	0	0
51	1	1	1	1	1	0	0	0	0	0
52	0	0	0	0	0	0	0	0	1	1
53	0	0	0	0	0	0	0	0	0	0
54	1	1	1	1	0	0	0	0	0	0
55	0	0	0	0	0	0	0	1	1	1
56	0	0	0	0	0	0	0	0	0	0
57	1	1	1	0	0	0	0	0	0	0
58	0	0	0	0	0	0	1	1	1	1
59	0	0	0	0	0	0	0	0	0	0
60	1	1	0	0	0	0	0	0	0	0
61	0	0	0	0	0	1	1	1	1	1
62	0	0	0	0	0	0	0	0	0	0
63	1	0	0	0	0	0	0	0	0	0
64	0	0	0	0	1	1	1	1	1	0
65	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	1	1	1	1	1	0	0
68	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	1	1	1	1	1	0	0	0
71	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0
73	0	1	1	1	1	1	0	0	0	0
74	0	0	0	0	0	0	0	0	0	1
75	0	0	0	0	0	0	0	0	0	0
+	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
1	0	0	0	0	0	0	0	0	0	0
2	1	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	0	1	1	1	1
4	0	0	0	0	0	0	0	0	0	0
5	1	1	0	0	0	0	0	0	0	0
6	0	0	0	0	0	1	1	1	1	1
7	0	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	0	0
9	0	0	0	0	1	1	1	1	1	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	1	1	1	1	1	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	1	1	1	1	1	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	1	1	1	1	1	0	0	0	0
19	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	0	0	0	0	0	0
21	1	1	1	1	1	0	0	0	0	0
22	0	0	0	0	0	0	0	0	1	1
23	0	0	0	0	0	0	0	0	0	0
24	1	1	1	1	0	0	0	0	0	0
25	0	0	0	0	0	0	0	1	1	1
26	0	0	0	0	0	0	0	0	0	0

27	1	1	1	0	0	0	0	0	0	0
28	0	0	0	0	0	0	1	1	1	1
29	0	0	0	0	0	0	0	0	0	0
30	1	1	0	0	0	0	0	0	0	0
31	0	0	0	0	0	1	1	1	1	1
32	0	0	0	0	0	0	0	0	0	0
33	1	0	0	0	0	0	0	0	0	0
34	0	0	0	0	1	1	1	1	1	0
35	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	1	1	1	1	1	0	0
38	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0
40	0	0	1	1	1	1	1	0	0	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0
43	0	1	1	1	1	1	0	0	0	0
44	0	0	0	0	0	0	0	0	0	1
45	0	0	0	0	0	0	0	0	0	0
46	1	1	1	1	1	0	0	0	0	0
47	0	0	0	0	0	0	0	0	1	1
48	0	0	0	0	0	0	0	0	0	0
49	1	1	1	1	0	0	0	0	0	0
50	0	0	0	0	0	0	0	1	1	1
51	0	0	0	0	0	0	0	0	0	0
52	1	1	1	0	0	0	0	0	0	0
53	0	0	0	0	0	0	1	1	1	1
54	0	0	0	0	0	0	0	0	0	0
55	1	1	0	0	0	0	0	0	0	0
56	0	0	0	0	0	1	1	1	1	1
57	0	0	0	0	0	0	0	0	0	0
58	1	0	0	0	0	0	0	0	0	0
59	0	0	0	0	1	1	1	1	1	0
60	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	1	1	1	1	1	0	0
63	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	1	1	1	1	1	0	0	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	1	1	1	1	1	0	0	0	0
69	0	0	0	0	0	0	0	0	0	1
70	0	0	0	0	0	0	0	0	0	0
71	1	1	1	1	1	0	0	0	0	0
72	0	0	0	0	0	0	0	0	1	1
73	0	0	0	0	0	0	0	0	0	0
74	1	1	1	1	0	0	0	0	0	0
75	0	0	0	0	0	0	0	1	1	1
+	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30
1	0	0	0	0	0	1	1	1	1	1
2	0	0	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	1	1	0

5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	1	1	1	1	1	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	1	1	1	1	1	0	0	0
11	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	0	0	0	0
13	0	1	1	1	1	1	0	0	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	1	1	1	0	0	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	0	0	0	0	0	0	0	0	0
19	1	1	1	1	0	0	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	0	0	0	0	0	0	0	0	0	0
22	1	1	1	0	0	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	1
24	0	0	0	0	0	0	0	0	0	0
25	1	1	0	0	0	0	0	0	0	0
26	0	0	0	0	0	1	0	0	1	1
27	0	0	0	0	0	0	0	0	0	0
28	1	0	0	0	0	0	0	0	0	0
29	0	0	0	0	1	0	0	1	1	1
30	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	1	1	0	1	1	1	0
33	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	0	1	1	1	1	1	1	0	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	1	1	1	1	1	1	0	0	0
39	0	0	0	0	0	0	0	0	0	1
40	0	0	0	0	0	0	0	0	0	0
41	1	1	1	1	1	1	0	0	0	0
42	0	0	0	0	0	0	0	0	1	1
43	0	0	0	0	0	0	0	0	0	0
44	1	1	1	1	0	0	0	0	0	0
45	0	0	0	0	0	0	0	1	1	0
46	0	0	0	0	0	0	0	0	0	0
47	1	1	1	0	0	0	0	0	0	0
48	0	0	0	0	0	0	1	1	0	0
49	0	0	0	0	0	0	0	0	0	0
50	1	1	0	0	0	0	0	0	0	0
51	0	0	0	0	0	1	1	0	0	1
52	0	0	0	0	0	0	0	0	0	0
53	1	0	0	0	0	0	0	0	0	0
54	0	0	0	0	1	1	0	0	1	1
55	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	0	1	1	0	0	1	1	1
58	0	0	0	0	0	0	0	0	0	0

59	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
60	**0**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**0**
61	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
59	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
60	**0**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**0**
61	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
62	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
63	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**
64	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
65	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
66	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**0**
67	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**
68	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
69	**1**	**1**	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**
70	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**
71	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
72	**1**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
73	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**
74	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
75	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
+	**S31**	**S32**	**S33**	**S34**	**S35**	**S36**	**S37**	**S38**	**S39**	**S40**
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	1	1	1	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	1	1	0	0	1	1	1	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	1	1	0	0	1	1	1	0	0	0
9	0	0	0	0	0	0	0	0	0	1
10	0	0	0	0	0	0	0	0	0	0
11	1	0	0	1	1	1	0	0	0	0
12	0	0	0	0	0	0	0	0	1	1
13	0	0	0	0	0	0	0	0	0	0
14	0	0	1	1	1	0	0	0	0	0
15	0	0	0	0	0	0	0	1	1	0
16	0	0	0	0	0	0	0	0	0	0
17	0	1	1	1	0	0	0	0	0	0
18	0	0	0	0	0	0	1	1	0	0
19	0	0	0	0	0	0	0	0	0	0
20	1	1	1	0	0	0	0	0	0	0
21	0	0	0	0	0	1	1	0	0	1
22	0	0	0	0	0	0	0	0	0	0
23	1	1	0	0	0	0	0	0	0	0
24	0	0	0	0	1	1	0	0	1	1
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	0	0	0	0	0
27	0	0	0	1	1	0	0	1	1	1
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0
30	0	0	1	1	0	0	1	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
33	0	1	1	0	0	1	1	1	0	0

34	0	0	0	0	0	0	0	0	0	1
35	0	0	0	0	0	0	0	0	0	0
36	1	1	0	0	1	1	1	0	0	0
37	0	0	0	0	0	0	0	0	1	1
38	0	0	0	0	0	0	0	0	0	0
39	1	0	0	1	1	1	0	0	0	0
40	0	0	0	0	0	0	0	1	1	1
41	0	0	0	0	0	0	0	0	0	0
42	0	0	1	1	1	0	0	0	0	0
43	0	0	0	0	0	0	1	1	1	1
44	0	0	0	0	0	0	0	0	0	0
45	0	1	1	1	0	0	0	0	0	0
46	0	0	0	0	0	1	1	1	1	1
47	0	0	0	0	0	0	0	0	0	0
48	1	1	1	0	0	0	0	0	0	0
49	0	0	0	0	1	1	1	1	1	0
50	0	0	0	0	0	0	0	0	0	0
51	1	1	0	0	0	0	0	0	0	0
52	0	0	0	1	1	1	1	1	0	0
53	0	0	0	0	0	0	0	0	0	0
54	1	0	0	0	0	0	0	0	0	0
55	0	0	1	1	1	1	1	0	0	0
56	0	0	0	0	0	0	0	0	0	1
57	0	0	0	0	0	0	0	0	0	0
58	0	1	1	1	1	1	0	0	0	0
59	0	0	0	0	0	0	0	0	1	1
60	0	0	0	0	0	0	0	0	0	0
61	1	1	1	1	1	0	0	0	0	0
62	0	0	0	0	0	0	0	1	1	0
63	0	0	0	0	0	0	0	0	0	0
64	1	1	1	1	0	0	0	0	0	0
65	0	0	0	0	0	0	1	1	0	0
66	0	0	0	0	0	0	0	0	0	0
67	1	1	1	0	0	0	0	0	0	0
68	0	0	0	0	0	1	1	0	0	1
69	0	0	0	0	0	0	0	0	0	0
70	1	1	0	0	0	0	0	0	0	0
71	0	0	0	0	1	1	0	0	1	1
72	0	0	0	0	0	0	0	0	0	0
73	1	0	0	0	0	0	0	0	0	0
74	0	0	0	1	1	0	0	1	1	1
75	0	0	0	0	0	0	0	0	0	0
+	S41	S42	S43	S44	S45	S46	S47	S48	S49	S50
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	1	1	0	0	1	1	1	0	0
4	0	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	0	0	0	0
6	1	1	0	0	1	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	0	0	0	0	0
9	1	0	0	1	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	1
11	0	0	0	0	0	0	0	0	0	0

12	0	0	1	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	1	1
14	0	0	0	0	0	0	0	0	0	0
15	0	1	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	1	1	1
17	0	0	0	0	0	0	0	0	0	0
18	1	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	1	1	1	0
20	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	1	1	1	0	0
23	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0
25	0	0	1	1	1	1	1	0	0	0
26	0	0	0	0	0	0	0	0	0	1
27	0	0	0	0	0	0	0	0	0	0
28	0	1	1	1	1	1	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	0	0	0	0	0	0	0
31	1	1	1	1	1	0	0	0	0	0
32	0	0	0	0	0	0	0	1	1	0
33	0	0	0	0	0	0	0	0	0	0
34	1	1	1	1	0	0	0	0	0	0
35	0	0	0	0	0	0	1	1	0	0
36	0	0	0	0	0	0	0	0	0	0
37	1	1	1	0	0	0	0	0	0	0
38	0	0	0	0	0	1	1	0	0	1
39	0	0	0	0	0	0	0	0	0	0
40	1	1	0	0	0	0	0	0	0	0
41	0	0	0	0	1	1	0	0	1	1
42	0	0	0	0	0	0	0	0	0	0
43	1	0	0	0	0	0	0	0	0	0
44	0	0	0	1	1	0	0	1	1	1
45	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	1	1	0	0	1	1	1	0
48	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0
50	0	1	1	0	0	1	1	1	0	0
51	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0
53	1	1	0	0	1	1	1	0	0	0
54	0	0	0	0	0	0	0	0	0	1
55	0	0	0	0	0	0	0	0	0	0
56	1	0	0	1	1	1	0	0	0	0
57	0	0	0	0	0	0	0	0	1	1
58	0	0	0	0	0	0	0	0	0	0
59	0	0	1	1	1	0	0	0	0	0
60	0	0	0	0	0	0	0	1	1	0
61	0	0	0	0	0	0	0	0	0	0
62	0	1	1	1	0	0	0	0	0	0
63	0	0	0	0	0	0	1	1	0	0
64	0	0	0	0	0	0	0	0	0	0
65	1	1	1	0	0	0	0	0	0	0

66	0	0	0	0	0	1	1	0	0	1
67	0	0	0	0	0	0	0	0	0	0
68	1	1	0	0	0	0	0	0	0	0
69	0	0	0	0	1	1	0	0	1	1
70	0	0	0	0	0	0	0	0	0	0
71	1	0	0	0	0	0	0	0	0	0
72	0	0	0	1	1	0	0	1	1	1
73	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0
75	0	0	1	1	0	0	1	1	1	0
+	S51	S52	S53	S54	S55	S56	S57	S58	S59	S60
1	1	1	1	1	1	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	1	1	1	1	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	1	1	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	1	1	0	0	1
10	1	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	1	1	0	0	1	1
13	1	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	1	1	0	0	1	1	1
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	1	1	0	0	1	1	1	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
21	0	1	1	0	0	1	1	1	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	1
24	1	1	0	0	1	1	1	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	1	1
27	1	0	0	1	1	1	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	1	1	0
30	0	0	1	1	1	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	1	1	0	0
33	0	1	1	1	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	1	1	0	0	1
36	1	1	1	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	1	1	0	0	1	1
39	1	1	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	1	1	0	0	1	1	1
42	1	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0

44	0	0	1	1	0	0	1	1	1	0
45	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	1	1	0	0	1	1	1	0	0
48	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	1
50	1	1	0	0	1	1	1	0	0	0
51	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	1	1
53	1	0	0	1	1	1	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	1	1	1
56	0	0	1	1	1	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	1	1	1	1
59	0	1	1	1	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	1	1	1	1	1
62	1	1	1	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	1	1	1	1	1	0
65	1	1	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	1	1	1	1	1	0	0
68	1	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	1	1	1	1	1	0	0	0
71	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	1
73	0	1	1	1	1	1	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	1	1
+	S61	S62	S63	S64	S65	S66	S67	S68	S69	S70
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	1	0	0
3	0	1	1	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	1	1	0	0	1
6	1	1	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	1	1	0	0	1	1
9	1	1	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	1	1	0	0	1	1	1
12	1	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	1	1	0	0	1	1	1	0
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	1	1	0	0	1	1	1	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	1
20	1	1	0	0	1	1	1	0	0	0
21	0	0	0	0	0	0	0	0	0	0

22	0	0	0	0	0	0	0	0	1	1
23	1	0	0	1	1	1	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	1	1	1
26	0	0	1	1	1	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	1	1	1	1
29	0	1	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	1	1	1	1	1
32	1	1	1	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	1	1	1	1	1	0
35	1	1	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	1	1	1	1	1	0	0
38	1	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0
40	0	0	1	1	1	1	1	0	0	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	1
43	0	1	1	1	1	1	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	1	1
46	1	1	1	1	1	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	1	1	0
49	1	1	1	1	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	1	1	0	0
52	1	1	1	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	1	1	0	0	1
55	1	1	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	1	1	0	0	1	1
58	1	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0
60	0	0	0	1	1	0	0	1	1	1
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0
63	0	0	1	1	0	0	1	1	1	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0
66	0	1	1	0	0	1	1	1	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	1
69	1	1	0	0	1	1	1	0	0	0
70	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	1	1
72	1	0	0	1	1	1	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	1	1	0
75	0	0	1	1	1	0	0	0	0	0

+	S71	S72	S73	S74	S75	S76	S77	S78	S79	S80
1	0	0	0	0	0	1	1	1	1	1
2	1	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	1	1	0
5	1	1	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	1	1	1	1	1	0	0
8	1	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	1	1	1	1	1	0	0	0
11	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	0	0	0	0
13	0	1	1	1	1	1	0	0	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	1	1	1	0	0	0	0	0
17	0	0	0	0	0	0	0	1	1	1
18	0	0	0	0	0	0	0	0	0	0
19	1	1	1	1	0	0	0	0	0	0
20	0	0	0	0	0	0	1	1	1	0
21	0	0	0	0	0	0	0	0	0	0
22	1	1	1	0	0	0	0	0	0	0
23	0	0	0	0	0	1	1	1	0	0
24	0	0	0	0	0	0	0	0	0	0
25	1	1	0	0	0	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	1
27	0	0	0	0	1	0	0	0	0	0
28	1	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	1	0	0	1	1
30	0	0	0	1	1	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	1	1	0
33	0	0	1	1	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	1	1	0	0
36	0	1	1	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	1	1	0	0	0
39	1	1	0	0	1	0	0	0	0	1
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	1	0	0	0	0
42	1	0	0	1	1	0	0	0	1	1
43	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	1	1	1	0	0	1	1	1
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	1	1	1	0	0	1	1	1	0
49	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
51	1	1	1	0	0	1	1	1	0	0
52	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	1	0	0	0	0	0

54	1	1	0	0	0	1	1	0	0	1
55	0	0	0	0	0	0	0	0	0	0
56	0	0	0	1	1	0	0	0	0	0
57	1	0	0	0	0	1	0	0	1	1
58	0	0	0	0	0	0	0	0	0	0
59	0	0	1	1	0	0	0	0	0	0
60	0	0	0	0	0	0	0	1	1	0
61	0	0	0	0	0	0	0	0	0	0
62	0	1	1	0	0	0	0	0	0	0
63	0	0	0	0	0	0	1	1	0	0
64	0	0	0	0	0	0	0	0	0	1
65	1	1	0	0	1	0	0	0	0	0
66	0	0	0	0	0	1	1	0	0	0
67	0	0	0	0	0	0	0	0	1	1
68	1	0	0	1	1	0	0	0	0	0
69	0	0	0	0	0	1	0	0	0	0
70	0	0	0	0	0	0	0	1	1	1
71	0	0	1	1	1	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	1	1	1	1
74	0	1	1	1	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0
+	S81	S82	S83	S84	S85	S86	S87	S88	S89	S90
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	1	0	0	1	1	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	1	1	1	0	0	1	1	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	1	1	1	0	0	1	1	0	0	0
9	0	0	0	0	0	0	0	0	0	1
10	0	0	0	0	0	0	0	0	0	0
11	1	1	0	0	1	1	0	0	0	0
12	0	0	0	0	0	0	0	0	1	1
13	0	0	0	0	0	0	0	0	0	0
14	1	0	0	1	1	0	0	0	0	0
15	0	0	0	0	0	0	0	1	1	1
16	0	0	0	0	0	0	0	0	0	0
17	0	0	1	1	0	0	0	0	0	0
18	0	0	0	0	0	0	1	1	1	0
19	0	0	0	0	0	0	0	0	0	0
20	0	1	1	0	0	0	0	0	0	0
21	0	0	0	0	0	1	1	1	0	0
22	0	0	0	0	0	0	0	0	0	0
23	1	1	0	0	0	0	0	0	0	0
24	0	0	0	0	1	1	1	0	0	1
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	0	0	0	0	0
27	0	0	0	1	1	1	0	0	1	1
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0
30	0	0	1	1	1	0	0	1	1	0
31	0	0	0	0	0	0	0	0	0	0

32	0	0	0	0	0	0	0	0	0	0
33	0	1	1	1	0	0	1	1	0	0
34	0	0	0	0	0	0	0	0	0	1
35	0	0	0	0	0	0	0	0	0	0
36	1	1	1	0	0	1	1	0	0	0
37	0	0	0	0	0	0	0	0	1	1
38	0	0	0	0	0	0	0	0	0	0
39	1	1	0	0	1	1	0	0	0	0
40	0	0	0	0	0	0	0	1	1	1
41	0	0	0	0	0	0	0	0	0	0
42	1	0	0	1	1	0	0	0	0	0
43	0	0	0	0	0	0	1	1	1	1
44	0	0	0	0	0	0	0	0	0	0
45	0	0	1	1	0	0	0	0	0	0
46	0	0	0	0	0	1	1	1	1	1
47	0	0	0	0	0	0	0	0	0	0
48	0	1	1	0	0	0	0	0	0	0
49	0	0	0	0	1	1	1	1	1	0
50	0	0	0	0	0	0	0	0	0	0
51	1	1	0	0	0	0	0	0	0	0
52	0	0	0	1	1	1	1	1	0	0
53	0	0	0	0	0	0	0	0	0	0
54	1	0	0	0	0	0	0	0	0	0
55	0	0	1	1	1	1	1	0	0	0
56	0	0	0	0	0	0	0	0	0	1
57	0	0	0	0	0	0	0	0	0	0
58	0	1	1	1	1	1	0	0	0	0
59	0	0	0	0	0	0	0	0	1	1
60	0	0	0	0	0	0	0	0	0	0
61	1	1	1	1	1	0	0	0	0	0
62	0	0	0	0	0	0	0	1	1	1
63	0	0	0	0	0	0	0	0	0	0
64	1	1	1	1	0	0	0	0	0	0
65	0	0	0	0	0	0	1	1	1	0
66	0	0	0	0	0	0	0	0	0	0
67	1	1	1	0	0	0	0	0	0	0
68	0	0	0	0	0	1	1	1	0	0
69	0	0	0	0	0	0	0	0	0	0
70	1	1	0	0	0	0	0	0	0	0
71	0	0	0	0	1	1	1	0	0	1
72	0	0	0	0	0	0	0	0	0	0
73	1	0	0	0	0	0	0	0	0	0
74	0	0	0	1	1	1	0	0	1	1
75	0	0	0	0	0	0	0	0	0	0
+	S91	S92	S93	S94	S95	S96	S97	S98	S99	S100
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	1	1	1	0	0	1	1	0	0
4	0	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	0	0	0	0
6	1	1	1	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	0	0	0	0	0
9	1	1	0	0	1	1	0	0	0	0

10	0	0	0	0	0	0	0	1	1	1
11	0	0	0	0	0	0	0	0	0	0
12	1	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	1	1
14	0	0	0	0	0	0	0	0	0	0
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	1	1	1
17	0	0	0	0	0	0	0	0	0	0
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	1	1	1	0
20	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	1	1	1	0	0
23	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0
25	0	0	1	1	1	1	1	0	0	0
26	0	0	0	0	0	0	0	0	0	1
27	0	0	0	0	0	0	0	0	0	0
28	0	1	1	1	1	1	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	0	0	0	0	0	0	0
31	1	1	1	1	1	0	0	0	0	0
32	0	0	0	0	0	0	0	1	1	1
33	0	0	0	0	0	0	0	0	0	0
34	1	1	1	1	0	0	0	0	0	0
35	0	0	0	0	0	0	1	1	1	0
36	0	0	0	0	0	0	0	0	0	0
37	1	1	1	0	0	0	0	0	0	0
38	0	0	0	0	0	1	1	1	0	0
39	0	0	0	0	0	0	0	0	0	0
40	1	1	0	0	0	0	0	0	0	0
41	0	0	0	0	1	1	1	0	0	1
42	0	0	0	0	0	0	0	0	0	0
43	1	0	0	0	0	0	0	0	0	0
44	0	0	0	1	1	1	0	0	1	1
45	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	1	1	1	0	0	1	1	0
48	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0
50	0	1	1	1	0	0	1	1	0	0
51	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0
53	1	1	1	0	0	1	1	0	0	0
54	0	0	0	0	0	0	0	0	0	1
55	0	0	0	0	0	0	0	0	0	0
56	1	1	0	0	1	1	0	0	0	0
57	0	0	0	0	0	0	0	0	1	1
58	0	0	0	0	0	0	0	0	0	0
59	1	0	0	1	1	0	0	0	0	0
60	0	0	0	0	0	0	0	1	1	1
61	0	0	0	0	0	0	0	0	0	0
62	0	0	1	1	0	0	0	0	0	0
63	0	0	0	0	0	0	1	1	1	0

64	0	0	0	0	0	0	0	0	0	0
65	0	1	1	0	0	0	0	0	0	0
66	0	0	0	0	0	1	1	1	0	0
67	0	0	0	0	0	0	0	0	0	0
68	1	1	0	0	0	0	0	0	0	0
69	0	0	0	0	1	1	1	0	0	1
70	0	0	0	0	0	0	0	0	0	0
71	1	0	0	0	0	0	0	0	0	0
72	0	0	0	1	1	1	0	0	1	1
73	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0
75	0	0	1	1	1	0	0	1	1	0
+	S101	S102	S103	S104	S105	S106	S107	S108	S109	S110
1	1	1	1	1	1	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	1
4	1	1	1	1	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	1	0
7	1	1	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	1	1	1	0	0
10	1	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	1	1	1	0	0	1
13	1	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	1	1	1	0	0	1	1
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	1	1	1	0	0	1	1	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
21	0	1	1	1	0	0	1	1	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	1
24	1	1	1	0	0	1	1	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	1	1
27	1	1	0	0	1	1	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	1	1	1
30	1	0	0	1	1	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	1	1	1	0
33	0	0	1	1	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	1	1	1	0	0
36	0	1	1	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	1	1	1	0	0	1
39	1	1	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	1	1	1	0	0	1	1

42	1	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0
44	0	0	1	1	1	0	0	1	1	0
45	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	1	1	1	0	0	1	1	0	0
48	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	1
50	1	1	1	0	0	1	1	0	0	0
51	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	1	1
53	1	1	0	0	1	1	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	1	1	1
56	1	0	0	1	1	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	1	1	1	1
59	0	0	1	1	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	1	1	1	1	1
62	0	1	1	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	1	1	1	1	1	0
65	1	1	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	1	1	1	1	1	0	0
68	1	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	1	1	1	1	1	0	0	0
71	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	1
73	0	1	1	1	1	1	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	1	1
+	S111	S112	S113	S114	S115	S116	S117	S118	S119	S120
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	1	1	0
3	0	0	1	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	1	1	1	0	0
6	0	1	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	1	1	1	0	0	1
9	1	1	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	1	1	1	0	0	1	1
12	1	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	1	1	1	0	0	1	1	0
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	1	1	1	0	0	1	1	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	1

20	1	1	1	0	0	1	1	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	1	1
23	1	1	0	0	1	1	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	1	1	1
26	1	0	0	1	1	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	1	1	1	1
29	0	0	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	1	1	1	1	1
32	0	1	1	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	1	1	1	1	1	0
35	1	1	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	1	1	1	1	1	0	0
38	1	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0
40	0	0	1	1	1	1	1	0	0	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	1
43	0	1	1	1	1	1	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	1	1
46	1	1	1	1	1	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	1	1	1
49	1	1	1	1	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	1	1	1	0
52	1	1	1	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	1	1	1	0	0
55	1	1	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	1	1	1	0	0	1
58	1	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0
60	0	0	0	1	1	1	0	0	1	1
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0
63	0	0	1	1	1	0	0	1	1	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0
66	0	1	1	1	0	0	1	1	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	1
69	1	1	1	0	0	1	1	0	0	0
70	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	1	1
72	1	1	0	0	1	1	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0

74	0	0	0	0	0	0	0	1	1	1
75	1	0	0	1	1	0	0	0	0	0
+	S121	S122	S123	S124	S125	S126	S127	S128	S129	S130
1	0	0	0	0	0	1	1	1	1	1
2	0	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	1	1	0
5	1	1	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	1	1	1	1	1	0	0
8	1	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	1	1	1	1	1	0	0	0
11	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	0	0	0	0
13	0	1	1	1	1	1	0	0	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	1	1	1	0	0	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	0	0	0	0	0	0	0	0	0
19	1	1	1	1	0	0	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	0	0	0	0	0	0	0	0	0	0
22	1	1	1	0	0	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	1
24	0	0	0	0	0	0	0	0	0	0
25	1	1	0	0	0	0	0	0	0	0
26	0	0	0	0	0	1	0	0	1	1
27	0	0	0	0	1	0	0	0	0	0
28	1	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	1	1	1
30	0	0	0	1	1	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	1	1	1	0
33	0	0	1	1	1	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	1	1	1	0	0
36	0	1	1	1	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	1	1	0	0	0
39	1	1	1	0	0	0	0	0	0	1
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	1	0	0	0	0
42	1	1	0	0	1	0	0	0	1	1
43	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	1	0	0	1	1	0	0	1	1	1
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	0	1	1	0	0	1	1	1	0
49	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
51	0	1	1	0	0	1	1	1	0	0

52	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	1	0	0	0	0	0
54	1	1	0	0	0	1	1	0	0	1
55	0	0	0	0	0	0	0	0	0	0
56	0	0	0	1	1	0	0	0	0	0
57	1	0	0	0	0	1	0	0	1	1
58	0	0	0	0	0	0	0	0	0	0
59	0	0	1	1	1	0	0	0	0	0
60	0	0	0	0	0	0	0	1	1	0
61	0	0	0	0	0	0	0	0	0	0
62	0	1	1	1	0	0	0	0	0	0
63	0	0	0	0	0	0	1	1	0	0
64	0	0	0	0	0	0	0	0	0	1
65	1	1	1	0	0	0	0	0	0	0
66	0	0	0	0	0	1	1	0	0	0
67	0	0	0	0	0	0	0	0	1	1
68	1	1	0	0	1	0	0	0	0	0
69	0	0	0	0	0	1	0	0	0	0
70	0	0	0	0	0	0	0	1	1	1
71	1	0	0	1	1	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	1	1	1	1
74	0	0	1	1	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0
+	S131	S132	S133	S134	S135	S136	S137	S138	S139	S140
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	1	1	1	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	1	1	0	0	1	1	1	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	1	1	0	0	1	1	1	0	0	0
9	0	0	0	0	0	0	0	0	0	1
10	0	0	0	0	0	0	0	0	0	0
11	1	0	0	1	1	1	0	0	0	0
12	0	0	0	0	0	0	0	0	1	1
13	0	0	0	0	0	0	0	0	0	0
14	0	0	1	1	1	0	0	0	0	0
15	0	0	0	0	0	0	0	1	1	1
16	0	0	0	0	0	0	0	0	0	0
17	0	1	1	1	0	0	0	0	0	0
18	0	0	0	0	0	0	1	1	1	0
19	0	0	0	0	0	0	0	0	0	0
20	1	1	1	0	0	0	0	0	0	0
21	0	0	0	0	0	1	1	1	0	0
22	0	0	0	0	0	0	0	0	0	0
23	1	1	0	0	0	0	0	0	0	0
24	0	0	0	0	1	1	1	0	0	1
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	0	0	0	0	0
27	0	0	0	1	1	1	0	0	1	1
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0

30	0	0	1	1	1	0	0	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
33	0	1	1	1	0	0	1	1	0	0
34	0	0	0	0	0	0	0	0	0	1
35	0	0	0	0	0	0	0	0	0	0
36	1	1	1	0	0	1	1	0	0	0
37	0	0	0	0	0	0	0	0	1	1
38	0	0	0	0	0	0	0	0	0	0
39	1	1	0	0	1	1	0	0	0	0
40	0	0	0	0	0	0	0	1	1	1
41	0	0	0	0	0	0	0	0	0	0
42	1	0	0	1	1	0	0	0	0	0
43	0	0	0	0	0	0	1	1	1	1
44	0	0	0	0	0	0	0	0	0	0
45	0	0	1	1	0	0	0	0	0	0
46	0	0	0	0	0	1	1	1	1	1
47	0	0	0	0	0	0	0	0	0	0
48	0	1	1	0	0	0	0	0	0	0
49	0	0	0	0	1	1	1	1	1	0
50	0	0	0	0	0	0	0	0	0	0
51	1	1	0	0	0	0	0	0	0	0
52	0	0	0	1	1	1	1	1	0	0
53	0	0	0	0	0	0	0	0	0	0
54	1	0	0	0	0	0	0	0	0	0
55	0	0	1	1	1	1	1	0	0	0
56	0	0	0	0	0	0	0	0	0	1
57	0	0	0	0	0	0	0	0	0	0
58	0	1	1	1	1	1	0	0	0	0
59	0	0	0	0	0	0	0	0	1	1
60	0	0	0	0	0	0	0	0	0	0
61	1	1	1	1	1	0	0	0	0	0
62	0	0	0	0	0	0	0	1	1	0
63	0	0	0	0	0	0	0	0	0	0
64	1	1	1	1	0	0	0	0	0	0
65	0	0	0	0	0	0	1	1	0	0
66	0	0	0	0	0	0	0	0	0	0
67	1	1	1	0	0	0	0	0	0	0
68	0	0	0	0	0	1	1	0	0	1
69	0	0	0	0	0	0	0	0	0	0
70	1	1	0	0	0	0	0	0	0	0
71	0	0	0	0	1	1	0	0	1	1
72	0	0	0	0	0	0	0	0	0	0
73	1	0	0	0	0	0	0	0	0	0
74	0	0	0	1	1	0	0	1	1	1
75	0	0	0	0	0	0	0	0	0	0
+	S141	S142	S143	S144	S145	S146	S147	S148	S149	S150
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	1	1	1	0	0	1	1	0	0
4	0	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	0	0	0	0
6	1	1	1	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1

8	0	0	0	0	0	0	0	0	0	0
9	1	1	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	1
11	0	0	0	0	0	0	0	0	0	0
12	1	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	1	1
14	0	0	0	0	0	0	0	0	0	0
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	1	1	1
17	0	0	0	0	0	0	0	0	0	0
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	1	1	1	0
20	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	1	1	1	0	0
23	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0
25	0	0	1	1	1	1	1	0	0	0
26	0	0	0	0	0	0	0	0	0	1
27	0	0	0	0	0	0	0	0	0	0
28	0	1	1	1	1	1	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	0	0	0	0	0	0	0
31	1	1	1	1	1	0	0	0	0	0
32	0	0	0	0	0	0	0	1	1	0
33	0	0	0	0	0	0	0	0	0	0
34	1	1	1	1	0	0	0	0	0	0
35	0	0	0	0	0	0	1	1	0	0
36	0	0	0	0	0	0	0	0	0	0
37	1	1	1	0	0	0	0	0	0	0
38	0	0	0	0	0	1	1	0	0	1
39	0	0	0	0	0	0	0	0	0	0
40	1	1	0	0	0	0	0	0	0	0
41	0	0	0	0	1	1	0	0	1	1
42	0	0	0	0	0	0	0	0	0	0
43	1	0	0	0	0	0	0	0	0	0
44	0	0	0	1	1	0	0	1	1	1
45	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	1	1	0	0	1	1	1	0
48	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0
50	0	1	1	0	0	1	1	1	0	0
51	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0
53	1	1	0	0	1	1	1	0	0	0
54	0	0	0	0	0	0	0	0	0	1
55	0	0	0	0	0	0	0	0	0	0
56	1	0	0	1	1	1	0	0	0	0
57	0	0	0	0	0	0	0	0	1	1
58	0	0	0	0	0	0	0	0	0	0
59	0	0	1	1	1	0	0	0	0	0
60	0	0	0	0	0	0	0	1	1	1
61	0	0	0	0	0	0	0	0	0	0

62	0	1	1	1	0	0	0	0	0	0
63	0	0	0	0	0	0	1	1	1	0
64	0	0	0	0	0	0	0	0	0	0
65	1	1	1	0	0	0	0	0	0	0
66	0	0	0	0	0	1	1	1	0	0
67	0	0	0	0	0	0	0	0	0	0
68	1	1	0	0	0	0	0	0	0	0
69	0	0	0	0	1	1	1	0	0	1
70	0	0	0	0	0	0	0	0	0	0
71	1	0	0	0	0	0	0	0	0	0
72	0	0	0	1	1	1	0	0	1	1
73	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0
75	0	0	1	1	1	0	0	1	1	0
+	S151	S152	S153	S154	S155	S156	S157	S158	S159	S160
1	1	1	1	1	1	0	0	0	0	0
2	0	0	0	0	0	0	0	1	1	1
3	0	0	0	0	0	0	0	0	0	0
4	1	1	1	1	0	0	0	0	0	0
5	0	0	0	0	0	0	1	1	1	0
6	0	0	0	0	0	0	0	0	0	0
7	1	1	1	0	0	0	0	0	0	0
8	0	0	0	0	0	1	1	1	0	0
9	0	0	0	0	0	0	0	0	0	0
10	1	1	0	0	0	0	0	0	0	0
11	0	0	0	0	1	1	1	0	0	1
12	0	0	0	0	0	0	0	0	0	0
13	1	0	0	0	0	0	0	0	0	0
14	0	0	0	1	1	1	0	0	1	1
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	1	1	1	0	0	1	1	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	1	1	1	0	0	1	1	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	1	1	1	0	0	1	1	0	0	0
24	0	0	0	0	0	0	0	0	0	1
25	0	0	0	0	0	0	0	0	0	0
26	1	1	0	0	1	1	0	0	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	0	0	0	0	0	0	0	0	0
29	1	0	0	1	1	0	0	0	0	0
30	0	0	0	0	0	0	0	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	1	1	0	0	0	0	0	0
33	0	0	0	0	0	0	1	1	0	0
34	0	0	0	0	0	0	0	0	0	0
35	∪	1	1	0	0	0	0	0	0	0
36	0	0	0	0	0	1	1	0	0	1
37	0	0	0	0	0	0	0	0	0	0
38	1	1	0	0	0	0	0	0	0	0
39	0	0	0	0	1	1	0	0	1	1

40	0	0	0	0	0	0	0	0	0	0
41	1	0	0	0	0	0	0	0	0	0
42	0	0	0	1	1	0	0	1	1	1
43	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	1	1	0	0	1	1	1	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	1	1	0	0	1	1	1	0	0
49	0	0	0	0	0	0	0	0	0	1
50	0	0	0	0	0	0	0	0	0	0
51	1	1	0	0	1	1	1	0	0	0
52	0	0	0	0	0	0	0	0	1	1
53	0	0	0	0	0	0	0	0	0	0
54	1	0	0	1	1	1	0	0	0	0
55	0	0	0	0	0	0	0	1	1	1
56	0	0	0	0	0	0	0	0	0	0
57	0	0	1	1	1	0	0	0	0	0
58	0	0	0	0	0	0	1	1	1	1
59	0	0	0	0	0	0	0	0	0	0
60	0	1	1	1	0	0	0	0	0	0
61	0	0	0	0	0	1	1	1	1	1
62	0	0	0	0	0	0	0	0	0	0
63	1	1	1	0	0	0	0	0	0	0
64	0	0	0	0	1	1	1	1	1	0
65	0	0	0	0	0	0	0	0	0	0
66	1	1	0	0	0	0	0	0	0	0
67	0	0	0	1	1	1	1	1	0	0
68	0	0	0	0	0	0	0	0	0	0
69	1	0	0	0	0	0	0	0	0	0
70	0	0	1	1	1	1	1	0	0	0
71	0	0	0	0	0	0	0	0	0	1
72	0	0	0	0	0	0	0	0	0	0
73	0	1	1	1	1	1	0	0	0	0
74	0	0	0	0	0	0	0	0	1	1
75	0	0	0	0	0	0	0	0	0	0
+	S161	S162	S163	S164	S165	S166	S167	S168	S169	S170
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	1	1	0	0	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	1
7	0	0	0	0	0	0	0	0	0	0
8	1	1	0	0	0	0	0	0	0	0
9	0	0	0	0	1	1	0	0	1	1
10	0	0	0	0	0	0	0	0	0	0
11	1	0	0	0	0	0	0	0	0	0
12	0	0	0	1	1	0	0	1	1	1
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	1	1	0	0	1	1	1	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0

18	0	1	1	0	0	1	1	1	0	0
19	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	1	1	1	0	0	0
22	0	0	0	0	0	0	0	0	1	1
23	0	0	0	0	0	0	0	0	0	0
24	1	0	0	1	1	1	0	0	0	0
25	0	0	0	0	0	0	0	1	1	1
26	0	0	0	0	0	0	0	0	0	0
27	0	0	1	1	1	0	0	0	0	0
28	0	0	0	0	0	0	1	1	1	1
29	0	0	0	0	0	0	0	0	0	0
30	0	1	1	1	0	0	0	0	0	0
31	0	0	0	0	0	1	1	1	1	1
32	0	0	0	0	0	0	0	0	0	0
33	1	1	1	0	0	0	0	0	0	0
34	0	0	0	0	1	1	1	1	1	0
35	0	0	0	0	0	0	0	0	0	0
36	1	1	0	0	0	0	0	0	0	0
37	0	0	0	1	1	1	1	1	0	0
38	0	0	0	0	0	0	0	0	0	0
39	1	0	0	0	0	0	0	0	0	0
40	0	0	1	1	1	1	1	0	0	0
41	0	0	0	0	0	0	0	0	0	1
42	0	0	0	0	0	0	0	0	0	0
43	0	1	1	1	1	1	0	0	0	0
44	0	0	0	0	0	0	0	0	1	1
45	0	0	0	0	0	0	0	0	0	0
46	1	1	1	1	1	0	0	0	0	0
47	0	0	0	0	0	0	0	1	1	1
48	0	0	0	0	0	0	0	0	0	0
49	1	1	1	1	0	0	0	0	0	0
50	0	0	0	0	0	0	1	1	1	0
51	0	0	0	0	0	0	0	0	0	0
52	1	1	1	0	0	0	0	0	0	0
53	0	0	0	0	0	1	1	1	0	0
54	0	0	0	0	0	0	0	0	0	0
55	1	1	0	0	0	0	0	0	0	0
56	0	0	0	0	1	1	1	0	0	1
57	0	0	0	0	0	0	0	0	0	0
58	1	0	0	0	0	0	0	0	0	0
59	0	0	0	1	1	1	0	0	1	1
60	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	1	1	1	0	0	1	1	0
63	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0
65	0	1	1	1	0	0	1	1	0	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0
68	1	1	1	0	0	1	1	0	0	0
69	0	0	0	0	0	0	0	0	0	1
70	0	0	0	0	0	0	0	0	0	0
71	1	1	0	0	1	1	0	0	0	0

72	0	0	0	0	0	0	0	0	1	1
73	0	0	0	0	0	0	0	0	0	0
74	1	0	0	1	1	0	0	0	0	0
75	0	0	0	0	0	0	0	1	1	0
+	S171	S172	S173	S174	S175	S176	S177	S178	S179	S180
1	0	0	0	0	0	1	1	1	1	1
2	0	0	0	0	0	0	0	0	0	0
3	1	1	1	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	1	1	0
5	0	0	0	0	0	0	0	0	0	0
6	1	1	0	0	0	0	0	0	0	0
7	0	0	0	1	1	1	1	1	0	0
8	0	0	0	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0	0
10	0	0	1	1	1	1	1	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	1
13	0	1	1	1	1	1	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	1	1
16	1	1	1	1	1	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	1	1	0
19	1	1	1	1	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	1	1	0	0
22	1	1	1	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	1	1	0	0	1
25	1	1	0	0	0	0	0	0	0	0
26	0	0	0	0	1	0	0	0	0	0
27	0	0	0	0	0	1	0	0	1	1
28	1	0	0	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	0	0	0	0	0	0	0	1	1	1
31	0	0	0	0	0	0	0	0	0	0
32	0	0	1	1	1	0	0	0	0	0
33	0	0	0	0	0	0	1	1	1	0
34	0	0	0	0	0	0	0	0	0	0
35	0	1	1	1	0	0	0	0	0	0
36	0	0	0	0	0	1	1	1	0	0
37	0	0	0	0	0	0	0	0	0	0
38	1	1	1	0	0	0	0	0	0	1
39	0	0	0	0	0	1	1	0	0	0
40	0	0	0	0	0	0	0	0	0	0
41	1	1	0	0	1	0	0	0	1	1
42	0	0	0	0	0	1	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0
44	1	0	0	1	1	0	0	1	1	1
45	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	1	1	0	0	1	1	1	0
48	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0

50	0	1	1	0	0	1	1	1	0	0
51	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0
53	1	1	0	0	0	1	1	0	0	1
54	0	0	0	0	1	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0
56	1	0	0	0	0	1	0	0	1	1
57	0	0	0	1	1	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	1	1	0
60	0	0	1	1	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	1	1	0	0
63	0	1	1	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	1
65	0	0	0	0	0	1	1	0	0	0
66	1	1	0	0	1	0	0	0	0	0
67	0	0	0	0	0	0	0	0	1	1
68	0	0	0	0	0	1	0	0	0	0
69	1	0	0	1	1	0	0	0	0	0
70	0	0	0	0	0	0	0	1	1	1
71	0	0	0	0	0	0	0	0	0	0
72	0	0	1	1	1	0	0	0	0	0
73	0	0	0	0	0	0	1	1	1	1
74	0	0	0	0	0	0	0	0	0	0
75	0	1	1	1	0	0	0	0	0	0
+	S181	S182	S183	S184	S185	S186	S187	S188	S189	S190
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	1	1	0	0	1	1	1	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	1	1	0	0	1	1	1	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	1
9	1	1	0	0	1	1	1	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	1	1
12	1	0	0	1	1	1	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	1	1	1
15	0	0	1	1	1	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	1	1	1	0
18	0	1	1	1	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	1	1	1	0	0
21	1	1	1	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	1	1	1	0	0	1
24	1	1	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	0	0	0	1	1	1	0	0	1	1
27	1	0	0	0	0	0	0	0	0	0

28	0	0	0	0	0	0	0	0	0	0
29	0	0	1	1	1	0	0	1	1	0
30	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0
32	0	1	1	1	0	0	1	1	0	0
33	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	1
35	1	1	1	0	0	1	1	0	0	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	1	1
38	1	1	0	0	1	1	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	1	1	1
41	1	0	0	1	1	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	1	1	1	1
44	0	0	1	1	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	1	1	1	1	1
47	0	1	1	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	1	1	1	1	1	0
50	1	1	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0
52	0	0	0	1	1	1	1	1	0	0
53	1	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0
55	0	0	1	1	1	1	1	0	0	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	1
58	0	1	1	1	1	1	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	1	1
61	1	1	1	1	1	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	1	1	0
64	1	1	1	1	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	1	1	0	0
67	1	1	1	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	1	1	0	0	1
70	1	1	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	1	1	0	0	1	1
73	1	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0
75	0	0	0	1	1	0	0	1	1	1
+	S191	S192	S193	S194	S195	S196	S197	S198	S199	S200
1	0	0	0	0	0	0	0	0	0	0
2	0	1	1	1	0	0	1	1	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	1
5	1	1	1	0	0	1	1	0	0	0

6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	1	0	0	1	1	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	1	1
11	1	0	0	1	1	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	1	1	1	1
14	0	0	1	1	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	1	1	1	1	1
17	0	1	1	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	1	1	1	1	1	0
20	1	1	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	1	1	1	1	1	0	0
23	1	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	1	1	1	1	1	0	0	0
26	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	1
28	0	1	1	1	1	1	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	1	1
31	1	1	1	1	1	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	1	1	0
34	1	1	1	1	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	1	1	0	0
37	1	1	1	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	1	1	0	0	1
40	1	1	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	1	1	0	0	1	1
43	1	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	0	1	1	0	0	1	1	1
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	0	1	1	0	0	1	1	1	0
49	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
51	0	1	1	0	0	1	1	1	0	0
52	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	1
54	1	1	0	0	1	1	1	0	0	0
55	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	1	1
57	1	0	0	1	1	1	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	1	1	1

60	0	0	1	1	1	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	1	1	1	0
63	0	1	1	1	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	1	1	1	0	0
66	1	1	1	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	1	1	1	0	0	1
69	1	1	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
71	0	0	0	1	1	1	0	0	1	1
72	1	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0
74	0	0	1	1	1	0	0	1	1	0
75	0	0	0	0	0	0	0	0	0	0
+	S201	S202	S203	S204	S205	S206	S207	S208	S209	S210
1	1	1	1	1	1	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	1
4	1	1	1	1	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	1	0
7	1	1	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	1	1	1	0	0
10	1	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	1	1	1	0	0	1
13	1	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	1	1	1	0	0	1	1
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	1	1	1	0	0	1	1	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
21	0	1	1	1	0	0	1	1	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	1
24	1	1	1	0	0	1	1	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	1	1
27	1	1	0	0	1	1	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	1	1	0
30	1	0	0	1	1	0	0	0	0	0
32	0	0	0	0	0	0	1	1	0	0
31	0	0	0	0	0	0	0	0	0	0
33	0	0	1	1	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	1	1	0	0	1
36	0	1	1	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0

38	0	0	0	0	1	1	0	0	1	1
39	1	1	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	1	1	0	0	1	1	1
42	1	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0
44	0	0	1	1	0	0	1	1	1	0
45	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	1	1	0	0	1	1	1	0	0
48	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	1
50	1	1	0	0	1	1	1	0	0	0
51	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	1	1
53	1	0	0	1	1	1	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	1	1	1
56	0	0	1	1	1	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	1	1	1	1
59	0	1	1	1	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	1	1	1	1	1
62	1	1	1	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	1	1	1	1	1	0
65	1	1	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	1	1	1	1	1	0	0
68	1	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	1	1	1	1	1	0	0	0
71	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	1
73	0	1	1	1	1	1	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	1	1
+	S211	S212	S213	S214	S215	S216	S217	S218	S219	S220
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	1	1	0	0
3	0	0	1	1	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	1	1	0	0	1
6	0	1	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	1	1	0	0	1	1
9	1	1	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	1	1	0	0	1	1	1
12	1	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	1	1	0	0	1	1	1	0
15	0	0	0	0	0	0	0	0	0	0

16	0	0	0	0	0	0	0	0	0	0
17	0	1	1	0	0	1	1	1	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	1
20	1	1	0	0	1	1	1	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	1	1
23	1	0	0	1	1	1	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	1	1	1
26	0	0	1	1	1	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	1	1	1	1
29	0	1	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	1	1	1	1	1
32	1	1	1	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	1	1	1	1	1	0
35	1	1	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	1	1	1	1	1	0	0
38	1	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0
40	0	0	1	1	1	1	1	0	0	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	1
43	0	1	1	1	1	1	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	1	1
46	1	1	1	1	1	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	1	1	1
49	1	1	1	1	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	1	1	1	0
52	1	1	1	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	1	1	1	0	0
55	1	1	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	1	1	1	0	0	1
58	1	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0
60	0	0	0	1	1	1	0	0	1	1
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0
63	0	0	1	1	1	0	0	1	1	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0
66	0	1	1	1	0	0	1	1	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	0	0	0	0	1
69	1	1	1	0	0	1	1	0	0	0

70	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	1	1
72	1	1	0	0	1	1	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	1	1	0
75	1	0	0	1	1	0	0	0	0	0
+	S221	S222	S223	S224	S225	S226	S227	S228	S229	S230
1	0	0	0	0	0	1	1	1	1	1
2	1	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	1	1	0
5	1	1	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	1	1	1	1	1	0	0
8	1	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	1	1	1	1	1	0	0	0
11	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	0	0	0	0
13	0	1	1	1	1	1	0	0	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	1	1	1	0	0	0	0	0
17	0	0	0	0	0	0	0	1	1	1
18	0	0	0	0	0	0	0	0	0	0
19	1	1	1	1	0	0	0	0	0	0
20	0	0	0	0	0	0	1	1	1	0
21	0	0	0	0	0	0	0	0	0	0
22	1	1	1	0	0	0	0	0	0	0
23	0	0	0	0	0	1	1	1	0	0
24	0	0	0	0	0	0	0	0	0	0
25	1	1	0	0	0	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	0
27	0	0	0	0	1	0	0	0	0	1
28	1	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	1	0	0	0	0
30	0	0	0	1	1	0	0	0	1	1
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
33	0	0	1	1	1	0	0	1	1	1
34	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0
36	0	1	1	1	0	0	1	1	1	0
37	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0
39	1	1	1	0	0	1	1	1	0	0
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	1
42	1	1	0	0	1	1	1	0	0	0
43	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	1	1
45	1	0	0	1	1	1	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	1	1	0

48	0	0	1	1	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	1	1	0	0
51	0	1	1	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	1	1	1	0	0	0
54	1	1	0	0	0	0	0	0	0	1
55	0	0	0	0	0	0	0	0	0	0
56	0	0	0	1	1	1	0	0	0	0
57	1	0	0	0	0	0	0	0	1	1
58	0	0	0	0	0	0	0	0	0	0
59	0	0	1	1	0	0	0	0	0	0
60	0	0	0	0	0	0	0	1	1	0
61	0	0	0	0	0	0	0	0	0	0
62	0	1	1	0	0	0	0	0	0	0
63	0	0	0	0	0	0	1	1	0	0
64	0	0	0	0	0	0	0	0	0	1
65	1	1	0	0	1	0	0	0	0	0
66	0	0	0	0	0	1	1	0	0	0
67	0	0	0	0	0	0	0	0	1	1
68	1	0	0	1	1	0	0	0	0	0
69	0	0	0	0	0	1	0	0	0	0
70	0	0	0	0	0	0	0	1	1	1
71	0	0	1	1	1	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	1	1	1	1
74	0	1	1	1	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0
+	S231	S232	S233	S234	S235	S236	S237	S238	S239	S240
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	1	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	1
4	0	0	0	0	0	0	0	0	0	0
5	0	1	1	1	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	1	0
7	0	0	0	0	0	0	0	0	0	0
8	1	1	1	0	0	0	0	0	0	0
9	0	0	0	0	0	1	1	1	0	0
10	0	0	0	0	0	0	0	0	0	0
11	1	1	0	0	0	0	0	0	0	1
12	0	0	0	0	1	1	1	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	1	0	0	0	0	0	0	0	1	1
15	0	0	0	1	1	1	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	0	1	1	1	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	0	1	1	1	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0
24	1	1	1	0	0	0	0	0	0	1
25	0	0	0	0	0	0	0	0	0	0

26	0	0	0	0	1	1	0	0	0	0
27	1	1	0	0	0	0	0	0	1	1
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	1	0	0	0	0	0	0	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	1	1	0	0	0	0	0	0
33	0	0	0	0	0	0	1	1	0	0
34	0	0	0	0	0	0	0	0	0	1
35	0	1	1	0	0	0	0	0	0	0
36	0	0	0	0	0	1	1	0	0	0
37	0	0	0	0	0	0	0	0	1	1
38	1	1	0	0	0	0	0	0	0	0
39	0	0	0	0	1	1	0	0	0	0
40	0	0	0	0	0	0	0	1	1	1
41	1	0	0	0	0	0	0	0	0	0
42	0	0	0	1	1	0	0	0	0	0
43	0	0	0	0	0	0	1	1	1	1
44	0	0	0	0	0	0	0	0	0	0
45	0	0	1	1	0	0	0	0	0	0
46	0	0	0	0	0	1	1	1	1	1
47	0	0	0	0	0	0	0	0	0	0
48	0	1	1	0	0	0	0	0	0	0
49	0	0	0	0	1	1	1	1	1	0
50	0	0	0	0	0	0	0	0	0	0
51	1	1	0	0	0	0	0	0	0	0
52	0	0	0	1	1	1	1	1	0	0
53	0	0	0	0	0	0	0	0	0	0
54	1	0	0	0	0	0	0	0	0	0
55	0	0	1	1	1	1	1	0	0	0
56	0	0	0	0	0	0	0	0	0	1
57	0	0	0	0	0	0	0	0	0	0
58	0	1	1	1	1	1	0	0	0	0
59	0	0	0	0	0	0	0	0	1	1
60	0	0	0	0	0	0	0	0	0	0
61	1	1	1	1	1	0	0	0	0	0
62	0	0	0	0	0	0	0	1	1	1
63	0	0	0	0	0	0	0	0	0	0
64	1	1	1	1	0	0	0	0	0	0
65	0	0	0	0	0	0	1	1	1	0
66	0	0	0	0	0	0	0	0	0	0
67	1	1	1	0	0	0	0	0	0	0
68	0	0	0	0	0	1	1	1	0	0
69	0	0	0	0	0	0	0	0	0	0
70	1	1	0	0	0	0	0	0	0	0
71	0	0	0	0	1	1	1	0	0	0
72	0	0	0	0	0	0	0	0	0	1
73	1	0	0	0	0	0	0	0	0	0
74	0	0	0	1	1	1	0	0	0	0
75	0	0	0	0	0	0	0	0	1	1
+	S241	S242	S243	S244	S245	S246	S247	S248	S249	S250
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0

4	0	0	0	0	0	0	0	0	0	1
5	0	1	1	0	0	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	1	0	0	0	0	0	0	0	0
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	1
11	1	0	0	0	0	0	0	0	0	0
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	1	1
14	0	0	0	0	0	0	0	0	0	0
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	1	1	1
17	0	0	0	0	0	0	0	0	0	0
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	1	1	1	0
20	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	1	1	1	0	0
23	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0
25	0	0	1	1	1	1	1	0	0	0
26	0	0	0	0	0	0	0	0	0	1
27	0	0	0	0	0	0	0	0	0	0
28	0	1	1	1	1	1	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	0	0	0	0	0	0	0
31	1	1	1	1	1	0	0	0	0	0
32	0	0	0	0	0	0	0	1	1	1
33	0	0	0	0	0	0	0	0	0	0
34	1	1	1	1	0	0	0	0	0	0
35	0	0	0	0	0	0	1	1	1	0
36	0	0	0	0	0	0	0	0	0	0
37	1	1	1	0	0	0	0	0	0	0
38	0	0	0	0	0	1	1	1	0	0
39	0	0	0	0	0	0	0	0	0	0
40	1	1	0	0	0	0	0	0	0	0
41	0	0	0	0	1	1	1	0	0	0
42	0	0	0	0	0	0	0	0	0	1
43	1	0	0	0	0	0	0	0	0	0
44	0	0	0	1	1	1	0	0	0	0
45	0	0	0	0	0	0	0	0	1	1
46	0	0	0	0	0	0	0	0	0	0
47	0	0	1	1	1	0	0	0	0	0
48	0	0	0	0	0	0	0	1	1	1
49	0	0	0	0	0	0	0	0	0	0
50	0	1	1	1	0	0	0	0	0	0
51	0	0	0	0	0	0	1	1	1	0
52	0	0	0	0	0	0	0	0	0	0
53	1	1	1	0	0	0	0	0	0	0
54	0	0	0	0	0	1	1	1	0	0
55	0	0	0	0	0	0	0	0	0	0
56	1	1	0	0	0	0	0	0	0	1
57	0	0	0	0	1	1	1	0	0	0

58	0	0	0	0	0	0	0	0	0	0
59	1	0	0	0	0	0	0	0	1	1
60	0	0	0	1	1	1	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	1	1	0
63	0	0	1	1	1	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	1	1	0	0
66	0	1	1	1	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	1	1	0	0	0
69	1	1	1	0	0	0	0	0	0	1
70	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	1	1	0	0	0	0
72	1	1	0	0	0	0	0	0	1	1
73	0	0	0	0	0	0	0	0	0	0
74	0	0	0	1	1	0	0	0	0	0
75	1	0	0	0	0	0	0	1	1	0
+	S251	S252	S253	S254	S255	S256	S257	S258	S259	S260
1	1	1	1	1	1	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	1
4	1	1	1	1	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	1	0
7	1	1	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	1	1	1	0	0
10	1	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	1	1	1	0	0	0
13	1	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	0	1	1	1	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	1	1	1
18	0	0	1	1	1	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	1	1	1	0
21	0	1	1	1	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	1	1	1	0	0
24	1	1	1	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	1	1	1	0	0	0
27	1	1	0	0	0	0	0	0	0	1
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	1	1	1	0	0	0	0
30	1	0	0	0	0	0	0	0	1	1
31	0	0	0	0	0	0	0	0	0	0
32	0	0	1	1	1	0	0	0	0	0
33	0	0	0	0	0	0	0	1	1	0
34	0	0	0	0	0	0	0	0	0	0
35	0	1	1	1	0	0	0	0	0	0

36	0	0	0	0	0	0	1	1	0	0
37	0	0	0	0	0	0	0	0	0	0
38	1	1	1	0	0	0	0	0	0	1
39	0	0	0	0	0	1	1	0	0	0
40	0	0	0	0	0	0	0	0	0	0
41	1	1	0	0	0	0	0	0	1	1
42	0	0	0	0	1	1	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0
44	1	0	0	0	0	0	0	1	1	0
45	0	0	0	1	1	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	1	1	0	0
48	0	0	1	1	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	1
50	0	0	0	0	0	1	1	0	0	0
51	0	1	1	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	1	1
53	0	0	0	0	1	1	0	0	0	0
54	1	1	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	1	1	1
56	0	0	0	1	1	0	0	0	0	0
57	1	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	1	1	1	1
59	0	0	-	1	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	1	1	1	1	1
62	0	1	1	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	1	1	1	1	1	0
65	1	1	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	1	1	1	1	1	0	0
68	1	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	1	1	1	1	1	0	0	0
71	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	1
73	0	1	1	1	1	1	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	1	1
+	S261	S262	S263	S264	S265	S266	S267	S268	S269	S270
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	1	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	0	0	0	0	0	0	0	0	0	0
5	0	1	1	1	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	0	0	0	0	0	0	0	0	0	0
8	1	1	1	0	0	0	0	0	0	1
9	0	0	0	0	0	1	1	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	1	1	0	0	0	0	0	0	1	1
12	0	0	0	0	1	1	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0

14	1	0	0	0	0	0	0	1	1	0
15	0	0	0	1	1	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	1	1	0	0
18	0	0	1	1	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	0	1	1	0	0	0
21	0	1	1	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	1	1
23	0	0	0	0	1	1	0	0	0	0
24	1	1	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	1	1	1
26	0	0	0	1	1	0	0	0	0	0
27	1	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	1	1	1	1
29	0	0	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	1	1	1	1	1
32	0	1	1	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	1	1	1	1	1	0
35	1	1	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	1	1	1	1	1	0	0
38	1	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0
40	0	0	1	1	1	1	1	0	0	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	1
43	0	1	1	1	1	1	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	1	1
46	1	1	1	1	1	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	1	1	1
49	1	1	1	1	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	1	1	1	0
52	1	1	1	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	1	1	1	0	0
55	1	1	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	1
57	0	0	0	0	1	1	1	0	0	0
58	1	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	1	1
60	0	0	0	1	1	1	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	1	1	1
63	0	0	1	1	1	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	1	1	1	0
66	0	1	1	1	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0

68	0	0	0	0	0	1	1	1	0	0
69	1	1	1	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	1	1	1	0	0	0
72	1	1	0	0	0	0	0	0	0	1
73	0	0	0	0	0	0	0	0	0	0
74	0	0	0	1	1	1	0	0	0	0
75	1	0	0	0	0	0	0	0	1	1
+	S271	S272	S273	S274	S275	S276	S277	S278	S279	S280
1	0	0	0	0	0	1	1	1	1	1
2	0	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	1	1	0
5	1	1	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	1	1	1	1	1	0	0
8	1	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	1	1	1	1	1	0	0	0
11	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	0	0	0	0
13	0	1	1	1	1	1	0	0	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	1	1	1	0	0	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	0	0	0	0	0	0	0	0	0
19	1	1	1	1	0	0	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	0	0	0	0	0	0	0	0	0	0
22	1	1	1	0	0	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0
24	0	0	0	0	0	0	0	0	0	1
25	1	1	0	0	0	0	0	0	0	0
26	0	0	0	0	0	1	0	0	0	0
27	0	0	0	0	1	0	0	0	1	1
28	1	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0
30	0	0	0	1	1	0	0	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
33	0	0	1	1	1	0	1	1	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	1
36	0	1	1	1	0	1	1	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	1	1
39	1	1	1	0	0	1	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	1	0	0	1	1	1
42	1	1	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0
44	0	0	0	1	1	0	1	1	1	0
45	1	0	0	0	0	0	0	0	0	0

46	0	0	0	0	0	0	0	0	0	0
47	0	0	1	1	1	1	1	1	0	0
48	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0
50	0	1	1	1	0	1	1	0	0	0
51	0	0	0	0	0	0	0	0	0	1
52	0	0	0	0	0	0	0	0	0	0
53	1	1	1	0	0	1	0	0	0	0
54	0	0	0	0	0	0	0	0	1	1
55	0	0	0	0	0	0	0	0	0	0
56	1	1	0	0	0	0	0	0	0	0
57	0	0	0	0	1	0	0	1	1	1
58	0	0	0	0	0	0	0	0	0	0
59	1	0	0	0	0	0	0	0	0	0
60	0	0	0	1	1	0	1	1	1	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0
63	0	0	1	1	0	1	1	1	0	0
64	0	0	0	0	0	0	0	0	0	1
65	0	0	0	0	0	0	0	0	0	0
66	0	1	1	0	0	1	1	0	0	0
67	0	0	0	0	0	0	0	0	1	1
68	0	0	0	0	1	0	0	0	0	0
69	1	1	0	0	0	1	0	0	0	0
70	0	0	0	0	0	0	0	1	1	1
71	0	0	0	1	1	0	0	0	0	0
72	1	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	1	1	1	1
74	0	0	1	1	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0
+	S281	S282	S283	S284	S285	S286	S287	S288	S289	S290
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	1	1	0	0	0	0	0	0	1
6	0	0	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	1	1	0	0	0	0	0	0	1	1
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	1	0	0	0	0	0	0	1	1	1
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	1	1	1	0
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	1	1	1	0	0
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	1	1	1	0	0	0
21	1	1	0	0	0	0	0	0	0	1
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	1	1	1	0	0	0	0

24	1	0	0	0	0	0	0	0	1	1
25	0	0	0	0	0	0	0	0	0	0
26	0	0	1	1	1	0	0	0	0	0
27	0	0	0	0	0	0	0	1	1	1
28	0	0	0	0	0	0	0	0	0	0
29	0	1	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	1	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	1	1	1	0	0	0	0	0	0	0
33	0	0	0	0	0	1	1	1	0	0
34	0	0	0	0	0	0	0	0	0	1
35	1	1	0	0	0	0	0	0	0	0
36	0	0	0	0	1	1	1	0	0	0
37	0	0	0	0	0	0	0	0	1	1
38	1	0	0	0	0	0	0	0	0	0
39	0	0	0	1	1	1	0	0	0	0
40	0	0	0	0	0	0	0	1	1	1
41	0	0	0	0	0	0	0	0	0	0
42	0	0	1	1	1	0	0	0	0	0
43	0	0	0	0	0	0	1	1	1	1
44	0	0	0	0	0	0	0	0	0	0
45	0	1	1	1	0	0	0	0	0	0
46	0	0	0	0	0	1	1	1	1	1
47	0	0	0	0	0	0	0	0	0	0
48	1	1	1	0	0	0	0	0	0	0
49	0	0	0	0	1	1	1	1	1	0
50	0	0	0	0	0	0	0	0	0	0
51	1	1	0	0	0	0	0	0	0	0
52	0	0	0	1	1	1	1	1	0	0
53	0	0	0	0	0	0	0	0	0	0
54	1	0	0	0	0	0	0	0	0	0
55	0	0	1	1	1	1	1	0	0	0
56	0	0	0	0	0	0	0	0	0	1
57	0	0	0	0	0	0	0	0	0	0
58	0	1	1	1	1	1	0	0	0	0
59	0	0	0	0	0	0	0	0	1	1
60	0	0	0	0	0	0	0	0	0	0
61	1	1	1	1	1	0	0	0	0	0
62	0	0	0	0	0	0	0	1	1	0
63	0	0	0	0	0	0	0	0	0	0
64	1	1	1	1	0	0	0	0	0	0
65	0	0	0	0	0	0	1	1	0	0
66	0	0	0	0	0	0	0	0	0	0
67	1	1	1	0	0	0	0	0	0	0
68	0	0	0	0	0	1	1	0	0	0
69	0	0	0	0	0	0	0	0	0	1
70	1	1	0	0	0	0	0	0	0	0
71	0	0	0	0	1	1	0	0	0	0
72	0	0	0	0	0	0	0	0	1	1
73	1	0	0	0	0	0	0	0	0	0
74	0	0	0	1	1	0	0	0	0	0
75	0	0	0	0	0	0	0	1	1	0
+	S291	S292	S293	S294	S295	S296	S297	S298	S299	S300
1	0	0	0	0	0	0	0	0	0	0

2	1	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	1	1	1	0	0
4	0	0	0	0	0	0	0	0	0	1
5	1	1	0	0	0	0	0	0	0	0
6	0	0	0	0	1	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	0	0	0	0	0	0	0	0	0
9	0	0	0	1	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	1
11	0	0	0	0	0	0	0	0	0	0
12	0	0	1	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	1	1
14	0	0	0	0	0	0	0	0	0	0
15	0	1	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	1	1	1
17	0	0	0	0	0	0	0	0	0	0
18	1	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	1	1	1	0
20	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	1	1	1	0	0
23	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0
25	0	0	1	1	1	1	1	0	0	0
26	0	0	0	0	0	0	0	0	0	1
27	0	0	0	0	0	0	0	0	0	0
28	0	1	1	1	1	1	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	0	0	0	0	0	0	0
31	1	1	1	1	1	0	0	0	0	0
32	0	0	0	0	0	0	0	1	1	0
33	0	0	0	0	0	0	0	0	0	0
34	1	1	1	1	0	0	0	0	0	0
35	0	0	0	0	0	0	1	1	0	0
36	0	0	0	0	0	0	0	0	0	0
37	1	1	1	0	0	0	0	0	0	0
38	0	0	0	0	0	1	1	0	0	0
39	0	0	0	0	0	0	0	0	0	1
40	1	1	0	0	0	0	0	0	0	0
41	0	0	0	0	1	1	0	0	0	0
42	0	0	0	0	0	0	0	0	1	1
43	1	0	0	0	0	0	0	0	0	0
44	0	0	0	1	1	0	0	0	0	0
45	0	0	0	0	0	0	0	1	1	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	1	1	0	0	0	0	0	0
48	0	0	0	0	0	0	1	1	0	0
49	0	0	0	0	0	0	0	0	0	0
50	0	1	1	0	0	0	0	0	0	1
51	0	0	0	0	0	1	1	0	0	0
52	0	0	0	0	0	0	0	0	0	0
53	1	1	0	0	0	0	0	0	1	1
54	0	0	0	0	1	1	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0

56	1	0	0	0	0	0	0	1	1	1
57	0	0	0	1	1	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	1	1	1	0
60	0	0	1	1	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	1	1	1	0	0
63	0	1	1	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	1	1	1	0	0	0
66	1	1	0	0	0	0	0	0	0	1
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	1	1	1	0	0	0	0
69	1	0	0	0	0	0	0	0	1	1
71	0	0	1	1	1	0	0	0	0	0
72	0	0	0	0	0	0	0	1	1	1
73	0	0	0	0	0	0	0	0	0	0
74	0	1	1	1	0	0	0	0	0	0
75	0	0	0	0	0	0	1	1	1	0
+	S301	S302	S303	S304	S305	S306	S307	S308	S309	S310
1	1	1	1	1	1	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	1	1	1	1	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	1	1	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	1
9	0	0	0	0	0	1	1	0	0	0
10	1	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	1	1
12	0	0	0	0	1	1	0	0	0	0
13	1	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	1	1	0
15	0	0	0	1	1	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	1	1	0	0
18	0	0	1	1	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	1	1	0	0	0
21	0	1	1	0	0	0	0	0	0	1
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	1	1	0	0	0	0
24	1	1	0	0	0	0	0	0	1	1
25	0	0	0	0	0	0	0	0	0	0
26	0	0	0	1	1	0	0	0	0	0
27	1	0	0	0	0	0	0	1	1	1
28	0	0	0	0	0	0	0	0	0	0
29	0	0	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	1	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	0	1	1	0	0	0	0	0	0	0
33	0	0	0	0	0	1	1	1	0	0
34	0	0	0	0	0	0	0	0	0	0

35	1	1	0	0	0	0	0	0	0	1
36	0	0	0	0	1	1	1	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	1	0	0	0	0	0	0	0	1	1
39	0	0	0	1	1	1	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	1	1	1
42	0	0	1	1	1	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	1	1	1	0
45	0	1	1	1	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	1	1	1	0	0
48	1	1	1	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	1
50	0	0	0	0	1	1	1	0	0	0
51	1	1	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	1	1
53	0	0	0	1	1	1	0	0	0	0
54	1	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	1	1	1
56	0	0	1	1	1	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	1	1	1	1
59	0	1	1	1	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	1	1	1	1	1
62	1	1	1	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	1	1	1	1	1	0
65	1	1	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	1	1	1	1	1	0	0
68	1	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	1	1	1	1	1	0	0	0
71	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	1
73	0	1	1	1	1	1	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	1	1
+	S311	S312	S313	S314	S315	S316	S317	S318	S319	S320
1	0	0	0	0	0	0	0	0	0	0
2	0	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	1	1	1	0	0
4	0	0	0	0	0	0	0	0	0	0
5	1	1	0	0	0	0	0	0	0	1
6	0	0	0	0	1	1	1	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	0	1	1
9	0	0	0	1	1	1	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	1	1	1

12	0	0	1	1	1	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	1	1	1	0
15	0	1	1	1	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	1	1	1	0	0
18	1	1	1	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	1	1	1	0	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	1	1
23	0	0	0	1	1	1	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	1	1	1
26	0	0	1	1	1	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	1	1	1	1
29	0	1	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	1	1	1	1	1
32	1	1	1	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	1	1	1	1	1	0
35	1	1	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	1	1	1	1	1	0	0
38	1	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0
40	0	0	1	1	1	1	1	0	0	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	1
43	0	1	1	1	1	1	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	1	1
46	1	1	1	1	1	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	1	1	0
49	1	1	1	1	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	1	1	0	0
52	1	1	1	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	1
54	0	0	0	0	0	1	1	0	0	0
55	1	1	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	1	1
57	0	0	0	0	1	1	0	0	0	0
58	1	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	1	1	0
60	0	0	0	1	1	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	1	1	0	0
63	0	0	1	1	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	1	1	0	0	0

66	0	1	1	0	0	0	0	0	0	1
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	1	1	0	0	0	0
69	1	1	0	0	0	0	0	0	1	1
70	0	0	0	0	0	0	0	0	0	0
71	0	0	0	1	1	0	0	0	0	0
72	1	0	0	0	0	0	0	1	1	1
73	0	0	0	0	0	0	0	0	0	0
74	0	0	1	1	0	0	0	0	0	0
75	0	0	0	0	0	0	1	1	1	0
+	S321	S322	S323	S324	S325	S326	S327	S328	S329	S330
1	0	0	0	0	0	1	1	1	1	1
2	1	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	1	1	0
5	1	1	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	1	1	1	1	1	0	0
8	1	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	1	1	1	1	1	0	0	0
11	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	0	0	0	0	0	0
13	0	1	1	1	1	1	0	0	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	1	1	1	0	0	0	0	0
17	0	0	0	0	0	0	0	1	1	1
18	0	0	0	0	0	0	0	0	0	0
19	1	1	1	1	0	0	0	0	0	0
20	0	0	0	0	0	0	1	1	1	0
21	0	0	0	0	0	0	0	0	0	0
22	1	1	1	0	0	0	0	0	0	0
23	0	0	0	0	0	1	1	1	0	0
24	0	0	0	0	0	0	0	0	0	0
25	1	1	0	0	0	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	0
27	0	0	0	0	1	0	0	0	0	1
28	1	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	1	0	0	0	0
30	0	0	0	1	1	0	0	0	1	1
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
33	0	0	1	1	0	0	0	1	1	0
34	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0
36	0	1	1	0	0	0	1	1	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	1	0	0	0	0	1
39	1	1	0	0	0	1	1	0	0	0
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	1	1	0	0	0	1	1
42	1	0	0	0	0	1	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0

44	0	0	1	1	0	0	0	1	1	0
45	0	0	0	0	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	1	1	0	0	0	1	1	0	0
48	0	0	0	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	0
50	1	1	0	0	0	1	1	0	0	0
51	0	0	0	0	1	0	0	0	0	1
52	0	0	0	0	0	0	0	0	0	0
53	1	0	0	0	0	1	0	0	0	0
54	0	0	0	1	1	0	0	0	1	1
55	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	1	1	1	0	0	1	1	1
58	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0
60	0	1	1	1	0	0	1	1	1	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0
63	1	1	1	0	0	1	1	1	0	0
64	0	0	0	0	0	0	0	0	0	1
65	0	0	0	0	1	0	0	0	0	0
66	1	1	0	0	0	1	1	0	0	0
67	0	0	0	0	0	0	0	0	1	1
68	0	0	0	1	1	0	0	0	0	0
69	1	0	0	0	0	1	0	0	0	0
70	0	0	0	0	0	0	0	1	1	1
71	0	0	1	1	1	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	1	1	1	1
74	0	1	1	1	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0
+	S331	S332	S333	S334	S335	S336	S337	S338	S339	S340
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	1	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	0
4	0	0	0	0	0	0	0	0	0	0
5	0	1	1	1	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	0	0
7	0	0	0	0	0	0	0	0	0	0
8	1	1	1	0	0	0	0	0	0	1
9	0	0	0	0	0	1	1	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	1	1	0	0	0	0	0	0	1	1
12	0	0	0	0	1	1	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	1	0	0	0	0	0	0	1	1	0
15	0	0	0	1	1	0	0	0	0	0
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17	0	0	0	0	0	0	1	1	0	0
18	0	0	1	1	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	1	1	0	0	0
21	0	1	1	0	0	0	0	0	0	1

22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	1	1	0	0	0	0
24	1	1	0	0	0	0	0	0	1	1
25	0	0	0	0	0	0	0	0	0	0
26	0	0	0	1	1	0	0	0	0	0
27	1	0	0	0	0	0	0	1	1	1
28	0	0	0	0	0	0	0	0	0	0
29	0	0	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	1	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	0	1	1	0	0	0	0	0	0	0
33	0	0	0	0	0	1	1	1	0	0
34	0	0	0	0	0	0	0	0	0	1
35	1	1	0	0	0	0	0	0	0	0
36	0	0	0	0	1	1	1	0	0	0
37	0	0	0	0	0	0	0	0	1	1
38	1	0	0	0	0	0	0	0	0	0
39	0	0	0	1	1	1	0	0	0	0
40	0	0	0	0	0	0	0	1	1	1
41	0	0	0	0	0	0	0	0	0	0
42	0	0	1	1	1	0	0	0	0	0
43	0	0	0	0	0	0	1	1	1	1
44	0	0	0	0	0	0	0	0	0	0
45	0	1	1	1	0	0	0	0	0	0
46	0	0	0	0	0	1	1	1	1	1
47	0	0	0	0	0	0	0	0	0	0
48	1	1	1	0	0	0	0	0	0	0
49	0	0	0	0	1	1	1	1	1	0
50	0	0	0	0	0	0	0	0	0	0
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52	0	0	0	1	1	1	1	1	0	0
53	0	0	0	0	0	0	0	0	0	0
54	1	0	0	0	0	0	0	0	0	0
55	0	0	1	1	1	1	1	0	0	0
56	0	0	0	0	0	0	0	0	0	1
57	0	0	0	0	0	0	0	0	0	0
58	0	1	1	1	1	1	0	0	0	0
59	0	0	0	0	0	0	0	0	1	1
60	0	0	0	0	0	0	0	0	0	0
61	1	1	1	1	1	0	0	0	0	0
62	0	0	0	0	0	0	0	1	1	1
63	0	0	0	0	0	0	0	0	0	0
64	1	1	1	1	0	0	0	0	0	0
65	0	0	0	0	0	0	1	1	1	0
66	0	0	0	0	0	0	0	0	0	0
67	1	1	1	0	0	0	0	0	0	0
68	0	0	0	0	0	1	1	1	0	0
69	0	0	0	0	0	0	0	0	0	0
70	1	1	0	0	0	0	0	0	0	0
71	0	0	0	0	1	1	1	0	0	0
72	0	0	0	0	0	0	0	0	0	1
73	1	0	0	0	0	0	0	0	0	0
74	0	0	0	1	1	1	0	0	0	0
75	0	0	0	0	0	0	0	0	1	1

+	S341	S342	S343	S344	S345	S346	S347	S348	S349	S350
1	0	0	0	0	0	0	0	0	0	0
2	0	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	1	1	1	0	0
4	0	0	0	0	0	0	0	0	0	1
5	1	1	0	0	0	0	0	0	0	0
6	0	0	0	0	1	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	1	0	0	0	0	0	0	0	0	0
9	0	0	0	1	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	1
11	0	0	0	0	0	0	0	0	0	0
12	0	0	1	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	1	1
14	0	0	0	0	0	0	0	0	0	0
15	0	1	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	1	1	1
17	0	0	0	0	0	0	0	0	0	0
18	1	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	1	1	1	0
20	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	1	1	1	0	0
23	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0
25	0	0	1	1	1	1	1	0	0	0
26	0	0	0	0	0	0	0	0	0	1
27	0	0	0	0	0	0	0	0	0	0
28	0	1	1	1	1	1	0	0	0	0
29	0	0	0	0	0	0	0	0	1	1
30	0	0	0	0	0	0	0	0	0	0
31	1	1	1	1	1	0	0	0	0	0
32	0	0	0	0	0	0	0	1	1	1
33	0	0	0	0	0	0	0	0	0	0
34	1	1	1	1	0	0	0	0	0	0
35	0	0	0	0	0	0	1	1	1	0
36	0	0	0	0	0	0	0	0	0	0
37	1	1	1	0	0	0	0	0	0	0
38	0	0	0	0	0	1	1	1	0	0
39	0	0	0	0	0	0	0	0	0	0
40	1	1	0	0	0	0	0	0	0	0
41	0	0	0	0	1	1	1	0	0	0
42	0	0	0	0	0	0	0	0	0	1
43	1	0	0	0	0	0	0	0	0	0
44	0	0	0	1	1	1	0	0	0	0
45	0	0	0	0	0	0	0	0	1	1
46	0	0	0	0	0	0	0	0	0	0
47	0	0	1	1	1	0	0	0	0	0
48	0	0	0	0	0	0	0	1	1	0
49	0	0	0	0	0	0	0	0	0	0
50	0	1	1	1	0	0	0	0	0	0
51	0	0	0	0	0	0	1	1	0	0
52	0	0	0	0	0	0	0	0	0	0
53	1	1	1	0	0	0	0	0	0	1
54	0	0	0	0	0	1	1	0	0	0

55	0	0	0	0	0	0	0	0	0	0
56	1	1	0	0	0	0	0	0	1	1
57	0	0	0	0	1	1	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0
59	1	0	0	0	0	0	0	1	1	0
60	0	0	0	1	1	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	1	1	0	0
63	0	0	1	1	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	1	1	0	0	0
66	0	1	1	0	0	0	0	0	0	1
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	1	1	0	0	0	0
69	1	1	0	0	0	0	0	0	1	1
70	0	0	0	0	0	0	0	0	0	0
71	0	0	0	1	1	0	0	0	0	0
72	1	0	0	0	0	0	0	1	1	1
73	0	0	0	0	0	0	0	0	0	0
74	0	0	1	1	0	0	0	0	0	0
75	0	0	0	0	0	0	1	1	1	0
+	S351	S352	S353	S354	S355	S356	S357	S358	S359	S360
1	1	1	1	1	1	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	1
4	1	1	1	1	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1	1	1	0
7	1	1	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	1	1	1	0	0
10	1	1	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	1
12	0	0	0	0	1	1	1	0	0	0
13	1	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	1	1
15	0	0	0	1	1	1	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	1	1	0
18	0	0	1	1	1	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	1	1	0	0
21	0	1	1	1	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	1	1	0	0	0
24	1	1	1	0	0	0	0	0	0	1
25	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	1	1	0	0	0	0
27	1	1	0	0	0	0	0	0	1	1
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	1	1	0	0	0	0	0
30	1	0	0	0	0	0	0	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	1	1	0	0	0	0	0	0

33	0	0	0	0	0	0	1	1	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	1	1	0	0	0	0	0	0	1
36	0	0	0	0	0	1	1	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	1	1	0	0	0	0	0	0	1	1
39	0	0	0	0	1	1	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
41	1	0	0	0	0	0	0	1	1	1
42	0	0	0	1	1	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	1	1	1	0
45	0	0	1	1	0	0	0	0	0	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	1	1	1	0	0
48	0	1	1	0	0	0	0	0	0	0
49	0	0	0	0	0	0	0	0	0	1
50	0	0	0	0	1	1	1	0	0	0
51	1	1	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	1	1
53	0	0	0	1	1	1	0	0	0	0
54	1	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	1	1	1
56	0	0	1	1	1	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	1	1	1	1
59	0	1	1	1	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	1	1	1	1	1
62	1	1	1	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	1	1	1	1	1	0
65	1	1	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	1	1	1	1	1	0	0
68	1	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	1	1	1	1	1	0	0	0
71	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	1
73	0	1	1	1	1	1	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	1	1
+	S361	S362	S363	S364	S365	S366	S367	S368	S369	S370
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	1	1	0	0	0	0	0	0	1
6	0	0	0	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	1	1	0	0	0	0	0	0	1	1
9	0	0	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0

11	1	0	0	0	0	0	0	1	1	1
12	0	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	1	1	1	0
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	1	1	1	0	0
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	1	1	1	0	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	1	1
23	0	0	0	1	1	1	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	1	1	1
26	0	0	1	1	1	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	1	1	1	1
29	0	1	1	1	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	1	1	1	1	1
32	1	1	1	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	1	1	1	1	1	0
35	1	1	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	1	1	1	1	1	0	0
38	1	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0
40	0	0	1	1	1	1	1	0	0	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	1
43	0	1	1	1	1	1	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	1	1
46	1	1	1	1	1	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	1	1	1
49	1	1	1	1	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	1	1	1	0
52	1	1	1	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	1	1	1	0	0
55	1	1	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	1
57	0	0	0	0	1	1	1	0	0	0
58	1	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	1	1
60	0	0	0	1	1	1	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	1	1	0
63	0	0	1	1	1	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0

65	0	0	0	0	0	0	1	1	0	0
66	0	1	1	1	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	0	0	0	0	1	1	0	0	0
69	1	1	1	0	0	0	0	0	0	1
70	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	1	1	0	0	0	0
72	1	1	0	0	0	0	0	0	1	1
73	0	0	0	0	0	0	0	0	0	0
74	0	0	0	1	1	0	0	0	0	0
75	1	0	0	0	0	0	0	1	1	0
+	S371	S372	S373	S374	S375	S376	S377	S378	S379	S380
1	0	0	0	0	0	1	1	1	0	0
2	1	1	1	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	0	0	1
5	1	1	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	1	1	1	0	0	1	1
8	1	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	0	1	1	1	0	0	1	1	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0
13	0	1	1	1	1	0	1	1	0	0
14	0	0	0	0	0	0	0	0	0	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	1	1	1	1	1	0	0	0
17	0	0	0	0	0	0	0	0	1	1
18	0	0	0	0	0	0	0	0	0	0
19	1	1	1	1	0	1	0	0	0	0
20	0	0	0	0	0	0	0	1	1	1
21	0	0	0	0	0	0	0	0	0	0
22	1	1	1	0	0	0	0	0	0	0
23	0	0	0	0	0	0	1	1	1	0
24	0	0	0	0	0	0	0	0	0	0
25	1	1	0	0	0	0	0	0	0	0
26	0	0	0	0	0	1	1	1	0	0
27	0	0	0	0	1	0	0	0	0	0
28	1	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	1	1	0	0	1
30	0	0	0	1	1	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	1	0	0	1	1
33	0	0	1	1	1	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	1	1	0
36	0	1	1	1	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	1	1	0	0
39	1	1	1	0	0	0	0	0	0	1
40	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	1	1	1	0	0	0
42	1	1	0	0	0	0	0	0	1	1

43	0	0	0	0	0	0	0	0	0	0
44	0	0	0	1	1	1	0	0	0	0
45	1	0	0	0	0	0	0	1	1	1
46	0	0	0	0	0	0	0	0	0	0
47	0	0	1	1	0	0	0	0	0	0
48	0	0	0	0	0	0	1	1	1	0
49	0	0	0	0	0	0	0	0	0	0
50	0	1	1	0	0	0	0	0	0	0
51	0	0	0	0	0	1	1	1	0	0
52	0	0	0	0	0	0	0	0	0	0
53	1	1	0	0	0	0	0	0	0	0
54	0	0	0	0	1	1	1	0	0	1
55	0	0	0	0	0	0	0	0	0	0
56	1	0	0	0	0	0	0	0	0	0
57	0	0	0	1	1	1	0	0	1	1
58	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0
60	0	0	1	1	0	0	0	1	1	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0
63	0	1	1	0	0	0	1	1	0	0
64	0	0	0	0	0	0	0	0	0	1
65	0	0	0	0	1	0	0	0	0	0
66	1	1	0	0	0	1	1	0	0	0
67	0	0	0	0	0	0	0	0	1	1
68	0	0	0	1	1	0	0	0	0	0
69	1	0	0	0	0	1	0	0	0	0
70	0	0	0	0	0	0	0	1	1	1
71	0	0	1	1	1	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	1	1	1	0
74	0	1	1	1	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0
+	S381	S382	S383	S384	S385	S386	S387	S388	S389	S390
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	1	1	0	0	1	1
3	0	0	0	0	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	0
5	0	0	1	1	1	0	0	1	1	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	1	1	1	0	0	1	1	0	0
9	0	0	0	0	0	0	0	0	0	1
10	0	0	0	0	0	0	0	0	0	0
11	1	1	1	0	0	1	1	0	0	0
12	0	0	0	0	0	0	0	0	1	1
13	0	0	0	0	0	0	0	0	0	0
14	1	1	0	0	1	1	0	0	0	0
15	0	0	0	0	0	0	0	1	1	1
16	0	0	0	0	0	0	0	0	0	0
17	1	0	0	1	1	0	0	0	0	0
18	0	0	0	0	0	0	1	1	1	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	1	1	0	0	0	0	0	1

21	0	0	0	0	0	1	1	1	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	1	1	0	0	0	0	0	0	0
24	0	0	0	0	1	1	1	0	0	1
25	0	0	0	0	0	0	0	0	0	0
26	1	1	0	0	0	0	0	0	0	0
27	0	0	0	1	1	1	0	0	1	1
28	0	0	0	0	0	0	0	0	0	0
29	1	0	0	0	0	0	0	0	0	0
30	0	0	1	1	1	0	0	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
33	0	1	1	1	0	0	1	1	0	0
34	0	0	0	0	0	0	0	0	0	1
35	0	0	0	0	0	0	0	0	0	0
36	1	1	1	0	0	1	1	0	0	0
37	0	0	0	0	0	0	0	0	1	1
38	0	0	0	0	0	0	0	0	0	0
39	1	1	0	0	1	1	0	0	0	0
40	0	0	0	0	0	0	0	1	1	1
41	0	0	0	0	0	0	0	0	0	0
42	1	0	0	1	1	0	0	0	0	0
43	0	0	0	0	0	0	1	1	1	0
44	0	0	0	0	0	0	0	0	0	0
45	0	0	1	1	0	0	0	0	0	0
46	0	0	0	0	0	1	1	1	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	1	1	0	0	0	0	0	0	0
49	0	0	0	0	1	1	1	0	0	1
50	0	0	0	0	0	0	0	0	0	0
51	1	1	0	0	0	0	0	0	0	0
52	0	0	0	1	1	1	0	0	1	1
53	0	0	0	0	0	0	0	0	0	0
54	1	0	0	0	0	0	0	0	0	0
55	0	0	1	1	1	0	0	1	1	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	1	1	1	0	0	1	1	0	0
59	0	0	0	0	0	0	0	0	0	1
60	0	0	0	0	0	0	0	0	0	0
61	1	1	1	0	0	1	1	0	0	0
62	0	0	0	0	0	0	0	0	1	1
63	0	0	0	0	0	0	0	0	0	0
64	1	1	0	0	1	1	0	0	0	0
65	0	0	0	0	0	0	0	1	1	1
66	0	0	0	0	0	0	0	0	0	0
67	1	0	0	1	1	0	0	0	0	0
68	0	0	0	0	0	0	1	1	1	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	1	1	0	0	0	0	0	0
71	0	0	0	0	0	1	1	1	0	0
72	0	0	0	0	0	0	0	0	0	0
73	0	1	1	0	0	0	0	0	0	0
74	0	0	0	0	1	1	1	0	0	1

75	0	0	0	0	0	0	0	0	0	0
+	S391	S392	S393	S394	S395	S396	S397	S398	S399	S400
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	1	1	1	0	0	1	1	0	0
4	0	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	0	0	0	0
6	1	1	1	0	0	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	0	0	0	0	0
9	1	1	0	0	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	1
11	0	0	0	0	0	0	0	0	0	0
12	1	0	0	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	1	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	1	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	1	0	0	1
20	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	1	0	0	1	1
23	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0
25	0	0	1	1	1	0	0	1	1	0
26	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0
28	0	1	1	1	0	0	1	1	0	0
29	0	0	0	0	0	0	0	0	0	1
30	0	0	0	0	0	0	0	0	0	0
31	1	1	1	0	0	1	1	0	0	0
32	0	0	0	0	0	0	0	0	1	1
33	0	0	0	0	0	0	0	0	0	0
34	1	1	0	0	1	1	0	0	0	0
35	0	0	0	0	0	0	0	1	1	1
36	0	0	0	0	0	0	0	0	0	0
37	1	0	0	1	1	0	0	0	0	0
38	0	0	0	0	0	0	1	1	1	0
39	0	0	0	0	0	0	0	0	0	0
40	0	0	1	1	0	0	0	0	0	0
41	0	0	0	0	0	1	1	1	0	0
42	0	0	0	0	0	0	0	0	0	0
43	0	1	1	0	0	0	0	0	0	0
44	0	0	0	0	1	1	1	0	0	1
45	0	0	0	0	0	0	0	0	0	0
46	1	1	0	0	0	0	0	0	0	0
47	0	0	0	1	1	1	0	0	1	1
48	0	0	0	0	0	0	0	0	0	0
49	1	0	0	0	0	0	0	0	0	0
50	0	0	1	1	1	0	0	1	1	0
51	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0

53	0	1	1	1	0	0	1	1	0	0
54	0	0	0	0	0	0	0	0	0	1
55	0	0	0	0	0	0	0	0	0	0
56	1	1	1	0	0	1	1	0	0	0
57	0	0	0	0	0	0	0	0	1	1
58	0	0	0	0	0	0	0	0	0	0
59	1	1	0	0	1	1	0	0	0	0
60	0	0	0	0	0	0	0	1	1	1
61	0	0	0	0	0	0	0	0	0	0
62	1	0	0	1	1	0	0	0	0	0
63	0	0	0	0	0	0	1	1	1	0
64	0	0	0	0	0	0	0	0	0	0
65	0	0	1	1	0	0	0	0	0	0
66	0	0	0	0	0	1	1	1	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	1	1	0	0	0	0	0	0	0
69	0	0	0	0	1	1	1	0	0	1
70	0	0	0	0	0	0	0	0	0	0
71	1	1	0	0	0	0	0	0	0	0
72	0	0	0	1	1	1	0	0	1	1
73	0	0	0	0	0	0	0	0	0	0
74	1	0	0	0	0	0	0	0	0	0
75	0	0	1	1	1	0	0	1	1	0
+	S401	S402	S403	S404	S405	S406	S407	S408	S409	S410
1	1	1	0	0	1	1	1	0	0	0
2	0	0	0	0	0	0	0	0	1	1
3	0	0	0	0	0	0	0	0	0	0
4	1	0	0	1	1	1	0	0	0	0
5	0	0	0	0	0	0	0	1	1	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	1	1	1	0	0	0	0	0
8	0	0	0	0	0	0	1	1	0	0
9	0	0	0	0	0	0	0	0	0	0
10	0	1	1	1	0	0	0	0	0	0
11	0	0	0	0	0	1	1	0	0	1
12	0	0	0	0	0	0	0	0	0	0
13	1	1	1	0	0	0	0	0	0	0
14	0	0	0	0	1	1	0	0	1	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	0	0	0	0	0	0	0	0
17	0	0	0	1	1	0	0	1	1	1
18	0	0	0	0	0	0	0	0	0	0
19	1	0	0	0	0	0	0	0	0	0
20	0	0	1	1	0	0	1	1	1	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	1	1	0	0	1	1	1	0	0
24	0	0	0	0	0	0	0	0	0	1
25	0	0	0	0	0	0	0	0	0	0
26	1	1	0	0	1	1	1	0	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	0	0	0	0	0	0	0	0	0
29	1	0	0	1	1	1	0	0	0	0
30	0	0	0	0	0	0	0	1	1	0

31	0	0	0	0	0	0	0	0	0	0
32	0	0	1	1	1	0	0	0	0	0
33	0	0	0	0	0	0	1	1	0	0
34	0	0	0	0	0	0	0	0	0	0
35	0	1	1	1	0	0	0	0	0	0
36	0	0	0	0	0	1	1	0	0	1
37	0	0	0	0	0	0	0	0	0	0
38	1	1	1	0	0	0	0	0	0	0
39	0	0	0	0	1	1	0	0	1	1
40	0	0	0	0	0	0	0	0	0	0
41	1	1	0	0	0	0	0	0	0	0
42	0	0	0	1	1	0	0	1	1	1
43	0	0	0	0	0	0	0	0	0	0
44	1	0	0	0	0	0	0	0	0	0
45	0	0	1	1	0	0	1	1	1	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	1	1	0	0	1	1	1	0	0
49	0	0	0	0	0	0	0	0	0	1
50	0	0	0	0	0	0	0	0	0	0
51	1	1	0	0	1	1	1	0	0	0
52	0	0	0	0	0	0	0	0	1	1
53	0	0	0	0	0	0	0	0	0	0
54	1	0	0	1	1	1	0	0	0	0
55	0	0	0	0	0	0	0	1	1	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	1	1	1	0	0	0	0	0
58	0	0	0	0	0	0	1	1	0	0
59	0	0	0	0	0	0	0	0	0	0
60	0	1	1	1	0	0	0	0	0	0
61	0	0	0	0	0	1	1	0	0	1
62	0	0	0	0	0	0	0	0	0	0
63	1	1	1	0	0	0	0	0	0	0
64	0	0	0	0	1	1	0	0	1	1
65	0	0	0	0	0	0	0	0	0	0
66	1	1	0	0	0	0	0	0	0	0
67	0	0	0	1	1	0	0	1	1	1
68	0	0	0	0	0	0	0	0	0	0
69	1	0	0	0	0	0	0	0	0	0
70	0	0	1	1	0	0	1	1	1	0
71	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0
73	0	1	1	0	0	1	1	1	0	0
74	0	0	0	0	0	0	0	0	0	1
75	0	0	0	0	0	0	0	0	0	0
+	S411	S412	S413	S414	S415	S416	S417	S418	S419	S420
1	0	0	0	0	0	0	0	0	0	0
2	0	0	1	1	1	0	0	0	0	0
3	0	0	0	0	0	0	1	1	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	1	1	1	0	0	0	0	0	0
6	0	0	0	0	0	1	1	0	0	1
7	0	0	0	0	0	0	0	0	0	0
8	1	1	1	0	0	0	0	0	0	0

9	0	0	0	0	1	1	0	0	1	1
10	0	0	0	0	0	0	0	0	0	0
11	1	1	0	0	0	0	0	0	0	0
12	0	0	0	1	1	0	0	1	1	1
13	0	0	0	0	0	0	0	0	0	0
14	1	0	0	0	0	0	0	0	0	0
15	0	0	1	1	0	0	1	1	1	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	1	1	0	0	1	1	1	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	1	1	1	0	0	0
22	0	0	0	0	0	0	0	0	1	1
23	0	0	0	0	0	0	0	0	0	0
24	1	0	0	1	1	1	0	0	0	0
25	0	0	0	0	0	0	0	1	1	0
26	0	0	0	0	0	0	0	0	0	0
27	0	0	1	1	1	0	0	0	0	0
28	0	0	0	0	0	0	1	1	0	0
29	0	0	0	0	0	0	0	0	0	0
30	0	1	1	1	0	0	0	0	0	0
31	0	0	0	0	0	1	1	0	0	1
32	0	0	0	0	0	0	0	0	0	0
33	1	1	1	0	0	0	0	0	0	0
34	0	0	0	0	1	1	0	0	1	1
35	0	0	0	0	0	0	0	0	0	0
36	1	1	0	0	0	0	0	0	0	0
37	0	0	0	1	1	0	0	1	1	1
38	0	0	0	0	0	0	0	0	0	0
39	1	0	0	0	0	0	0	0	0	0
40	0	0	1	1	0	0	1	1	1	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0
43	0	1	1	0	0	1	1	1	0	0
44	0	0	0	0	0	0	0	0	0	1
45	0	0	0	0	0	0	0	0	0	0
46	1	1	0	0	1	1	1	0	0	0
47	0	0	0	0	0	0	0	0	1	1
48	0	0	0	0	0	0	0	0	0	0
49	1	0	0	1	1	1	0	0	0	0
50	0	0	0	0	0	0	0	1	1	0
51	0	0	0	0	0	0	0	0	0	0
52	0	0	1	1	1	0	0	0	0	0
53	0	0	0	0	0	0	1	1	0	0
54	0	0	0	0	0	0	0	0	0	0
55	0	1	1	1	0	0	0	0	0	0
56	0	0	0	0	0	1	1	0	0	1
57	0	0	0	0	0	0	0	0	0	0
58	1	1	1	0	0	0	0	0	0	0
59	0	0	0	0	1	1	0	0	1	1
60	0	0	0	0	0	0	0	0	0	0
61	1	1	0	0	0	0	0	0	0	0
62	0	0	0	1	1	0	0	1	1	1

63	0	0	0	0	0	0	0	0	0	0
64	1	0	0	0	0	0	0	0	0	0
65	0	0	1	1	0	0	1	1	1	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	1	1	0	0	1	1	1	0	0
69	0	0	0	0	0	0	0	0	0	1
70	0	0	0	0	0	0	0	0	0	0
71	1	1	0	0	1	1	1	0	0	0
72	0	0	0	0	0	0	0	0	1	1
73	0	0	0	0	0	0	0	0	0	0
74	1	0	0	1	1	1	0	0	0	0
75	0	0	0	0	0	0	0	1	1	0
+	S421	S422	S423	S424	S425	S426	S427	S428	S429	S430
1	0	0	0	0	0	1	1	1	0	0
2	0	0	0	0	0	0	0	0	0	0
3	1	1	1	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	0	0	1
5	0	0	0	0	0	0	0	0	0	0
6	1	1	0	0	0	0	0	0	0	0
7	0	0	0	1	1	1	0	0	1	1
8	0	0	0	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0	0
10	0	0	1	1	0	0	0	1	1	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0
13	0	1	1	0	0	0	1	1	0	0
14	0	0	0	0	0	0	0	0	0	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	0	0	1	1	1	0	0	0
17	0	0	0	0	0	0	0	0	1	1
18	0	0	0	0	0	0	0	0	0	0
19	1	0	0	1	1	1	0	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	1	1	1	0	0	0	0	0
23	0	0	0	0	0	0	1	1	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	1	1	1	0	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	1
27	0	0	0	0	0	0	0	0	0	0
28	1	1	1	0	0	0	0	0	0	0
29	0	0	0	0	1	1	0	0	1	1
30	0	0	0	0	0	0	0	0	0	0
31	1	1	0	0	0	0	0	0	0	0
32	0	0	0	1	1	0	0	1	1	1
33	0	0	0	0	0	0	0	0	0	0
34	1	0	0	0	0	0	0	0	0	0
35	0	0	1	1	0	0	1	1	1	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	1	1	0	0	1	1	1	0	0
39	0	0	0	0	0	0	0	0	0	1
40	0	0	0	0	0	0	0	0	0	0

41	1	1	0	0	1	1	1	0	0	0
42	0	0	0	0	0	0	0	0	1	1
43	0	0	0	0	0	0	0	0	0	0
44	1	0	0	1	1	1	0	0	0	0
45	0	0	0	0	0	0	0	1	1	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	1	1	1	0	0	0	0	0
48	0	0	0	0	0	0	1	1	0	0
49	0	0	0	0	0	0	0	0	0	0
50	0	1	1	1	0	0	0	0	0	0
51	0	0	0	0	0	1	1	0	0	1
52	0	0	0	0	0	0	0	0	0	0
53	1	1	1	0	0	0	0	0	0	0
54	0	0	0	0	1	1	0	0	1	1
55	0	0	0	0	0	0	0	0	0	0
56	1	1	0	0	0	0	0	0	0	0
57	0	0	0	1	1	0	0	1	1	1
58	0	0	0	0	0	0	0	0	0	0
59	1	0	0	0	0	0	0	0	0	0
60	0	0	1	1	0	0	1	1	1	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0
63	0	1	1	0	0	1	1	1	0	0
64	0	0	0	0	0	0	0	0	0	1
65	0	0	0	0	0	0	0	0	0	0
66	1	1	0	0	1	1	1	0	0	0
67	0	0	0	0	0	0	0	0	1	1
68	0	0	0	0	0	0	0	0	0	0
69	1	0	0	1	1	1	0	0	0	0
70	0	0	0	0	0	0	0	1	1	1
71	0	0	0	0	0	0	0	0	0	0
72	0	0	1	1	1	0	0	0	0	0
73	0	0	0	0	0	0	1	1	1	0
74	0	0	0	0	0	0	0	0	0	0
75	0	1	1	1	0	0	0	0	0	0
+	S431	S432	S433	S434	S435	S436	S437	S438	S439	S440
1	1	1	0	0	0	0	0	0	0	0
2	0	0	0	1	1	0	0	1	1	1
3	0	0	0	0	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	0
5	0	0	1	1	0	0	1	1	1	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	1	1	0	0	1	1	1	0	0
9	0	0	0	0	0	0	0	0	0	1
10	0	0	0	0	0	0	0	0	0	0
11	1	1	0	0	1	1	1	0	0	0
12	0	0	0	0	0	0	0	0	1	1
13	0	0	0	0	0	0	0	0	0	0
14	1	0	0	1	1	1	0	0	0	0
15	0	0	0	0	0	0	0	1	1	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	1	1	1	0	0	0	0	0
18	0	0	0	0	0	0	1	1	0	0

19	0	0	0	0	0	0	0	0	0	0
20	0	1	1	1	0	0	0	0	0	0
21	0	0	0	0	0	1	1	0	0	1
22	0	0	0	0	0	0	0	0	0	0
23	1	1	1	0	0	0	0	0	0	0
24	0	0	0	0	1	1	0	0	1	1
25	0	0	0	0	0	0	0	0	0	0
26	1	1	0	0	0	0	0	0	0	0
27	0	0	0	1	1	0	0	1	1	1
28	0	0	0	0	0	0	0	0	0	0
29	1	0	0	0	0	0	0	0	0	0
30	0	0	1	1	0	0	1	1	1	0
31	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
33	0	1	1	0	0	1	1	1	0	0
34	0	0	0	0	0	0	0	0	0	1
35	0	0	0	0	0	0	0	0	0	0
36	1	1	0	0	1	1	1	0	0	0
37	0	0	0	0	0	0	0	0	1	1
38	0	0	0	0	0	0	0	0	0	0
39	1	0	0	1	1	1	0	0	0	0
40	0	0	0	0	0	0	0	1	1	1
41	0	0	0	0	0	0	0	0	0	0
42	0	0	1	1	1	0	0	0	0	0
43	0	0	0	0	0	0	1	1	1	0
44	0	0	0	0	0	0	0	0	0	0
45	0	1	1	1	0	0	0	0	0	0
46	0	0	0	0	0	1	1	1	0	0
47	0	0	0	0	0	0	0	0	0	0
48	1	1	1	0	0	0	0	0	0	0
49	0	0	0	0	1	1	1	0	0	1
50	0	0	0	0	0	0	0	0	0	0
51	1	1	0	0	0	0	0	0	0	0
52	0	0	0	1	1	1	0	0	1	1
53	0	0	0	0	0	0	0	0	0	0
54	1	0	0	0	0	0	0	0	0	0
55	0	0	1	1	1	0	0	1	1	0
56	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0
58	0	1	1	1	0	0	1	1	0	0
59	0	0	0	0	0	0	0	0	0	1
60	0	0	0	0	0	0	0	0	0	0
61	1	1	1	0	0	1	1	0	0	0
62	0	0	0	0	0	0	0	0	1	1
63	0	0	0	0	0	0	0	0	0	0
64	1	1	0	0	1	1	0	0	0	0
65	0	0	0	0	0	0	0	1	1	0
66	0	0	0	0	0	0	0	0	0	0
67	1	0	0	1	1	0	0	0	0	0
68	0	0	0	0	0	0	1	1	0	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	1	1	0	0	0	0	0	0
71	0	0	0	0	0	1	1	0	0	1
72	0	0	0	0	0	0	0	0	0	0

73	0	1	1	0	0	0	0	0	0	0
74	0	0	0	0	1	1	0	0	1	1
75	0	0	0	0	0	0	0	0	0	0
+	S441	S442	S443	S444	S445	S446	S447	S448	S449	S450
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	1	1	0	0	1	1	1	0	0
4	0	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	0	0	0	0
6	1	1	0	0	1	1	1	0	0	0
7	0	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	0	0	0	0	0
9	1	0	0	1	1	1	0	0	0	0
10	0	0	0	0	0	0	0	1	1	1
11	0	0	0	0	0	0	0	0	0	0
12	0	0	1	1	1	0	0	0	0	0
13	0	0	0	0	0	0	1	1	1	0
14	0	0	0	0	0	0	0	0	0	0
15	0	1	1	1	0	0	0	0	0	0
16	0	0	0	0	0	1	1	1	0	0
17	0	0	0	0	0	0	0	0	0	0
18	1	1	1	0	0	0	0	0	0	0
19	0	0	0	0	1	1	1	0	0	1
20	0	0	0	0	0	0	0	0	0	0
21	1	1	0	0	0	0	0	0	0	0
22	0	0	0	1	1	1	0	0	1	1
23	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0
25	0	0	1	1	1	0	0	1	1	0
26	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0
28	0	1	1	1	0	0	1	1	0	0
29	0	0	0	0	0	0	0	0	0	1
30	0	0	0	0	0	0	0	0	0	0
31	1	1	1	0	0	1	1	0	0	0
32	0	0	0	0	0	0	0	0	1	1
33	0	0	0	0	0	0	0	0	0	0
34	1	1	0	0	1	1	0	0	0	0
35	0	0	0	0	0	0	0	1	1	0
36	0	0	0	0	0	0	0	0	0	0
37	1	0	0	1	1	0	0	0	0	0
38	0	0	0	0	0	0	1	1	0	0
39	0	0	0	0	0	0	0	0	0	0
40	0	0	1	1	0	0	0	0	0	0
41	0	0	0	0	0	1	1	0	0	1
42	0	0	0	0	0	0	0	0	0	0
43	0	1	1	0	0	0	0	0	0	0
44	0	0	0	0	1	1	0	0	1	1
45	0	0	0	0	0	0	0	0	0	0
46	1	1	0	0	0	0	0	0	0	0
47	0	0	0	1	1	0	0	1	1	1
48	0	0	0	0	0	0	0	0	0	0
49	1	0	0	0	0	0	0	0	0	0
50	0	0	1	1	0	0	1	1	1	0

51	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0
53	0	1	1	0	0	1	1	1	0	0
54	0	0	0	0	0	0	0	0	0	1
55	0	0	0	0	0	0	0	0	0	0
56	1	1	0	0	1	1	1	0	0	0
57	0	0	0	0	0	0	0	0	1	1
58	0	0	0	0	0	0	0	0	0	0
59	1	0	0	1	1	1	0	0	0	0
60	0	0	0	0	0	0	0	1	1	0
61	0	0	0	0	0	0	0	0	0	0
62	0	0	1	1	1	0	0	0	0	0
63	0	0	0	0	0	0	1	1	0	0
64	0	0	0	0	0	0	0	0	0	0
65	0	1	1	1	0	0	0	0	0	0
66	0	0	0	0	0	1	1	0	0	1
67	0	0	0	0	0	0	0	0	0	0
68	1	1	1	0	0	0	0	0	0	0
69	0	0	0	0	1	1	0	0	1	1
70	0	0	0	0	0	0	0	0	0	0
71	1	1	0	0	0	0	0	0	0	0
72	0	0	0	1	1	0	0	1	1	1
73	0	0	0	0	0	0	0	0	0	0
74	1	0	0	0	0	0	0	0	0	0
75	0	0	1	1	0	0	1	1	1	0
+	S451	S452	S453	S454	S455	S456	S457	S458	S459	S460
1	1	1	0	0	1	1	1	0	0	0
2	0	0	0	0	0	0	0	0	1	1
3	0	0	0	0	0	0	0	0	0	0
4	1	0	0	1	1	1	0	0	0	0
5	0	0	0	0	0	0	0	1	1	1
6	0	0	0	0	0	0	0	0	0	0
7	0	0	1	1	1	0	0	0	0	0
8	0	0	0	0	0	0	1	1	1	0
9	0	0	0	0	0	0	0	0	0	0
10	0	1	1	1	0	0	0	0	0	0
11	0	0	0	0	0	1	1	1	0	0
12	0	0	0	0	0	0	0	0	0	0
13	1	1	1	0	0	0	0	0	0	0
14	0	0	0	0	1	1	1	0	0	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	0	0	0	0	0	0	0	0
17	0	0	0	1	1	1	0	0	1	1
18	0	0	0	0	0	0	0	0	0	0
19	1	0	0	0	0	0	0	0	0	0
20	0	0	1	1	1	0	0	1	1	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	1	1	1	0	0	1	1	0	0
24	0	0	0	0	0	0	0	0	0	1
25	0	0	0	0	0	0	0	0	0	0
26	1	1	1	0	0	1	1	0	0	0
27	0	0	0	0	0	0	0	0	1	1
28	0	0	0	0	0	0	0	0	0	0

29	1	1	0	0	1	1	0	0	0	0
30	0	0	0	0	0	0	0	1	1	1
31	0	0	0	0	0	0	0	0	0	0
32	1	0	0	1	1	0	0	0	0	0
33	0	0	0	0	0	0	1	1	1	0
34	0	0	0	0	0	0	0	0	0	0
35	0	0	1	1	0	0	0	0	0	0
36	0	0	0	0	0	1	1	1	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	1	1	0	0	0	0	0	0	0
39	0	0	0	0	1	1	1	0	0	1
40	0	0	0	0	0	0	0	0	0	0
41	1	1	0	0	0	0	0	0	0	0
42	0	0	0	1	1	1	0	0	1	1
43	0	0	0	0	0	0	0	0	0	0
44	1	0	0	0	0	0	0	0	0	0
45	0	0	1	1	1	0	0	1	1	0
46	0	0	0	0	0	0	0	0	0	0
47	0	0	0	0	0	0	0	0	0	0
48	0	1	1	1	0	0	1	1	0	0
49	0	0	0	0	0	0	0	0	0	1
50	0	0	0	0	0	0	0	0	0	0
51	1	1	1	0	0	1	1	0	0	0
52	0	0	0	0	0	0	0	0	1	1
53	0	0	0	0	0	0	0	0	0	0
54	1	1	0	0	1	1	0	0	0	0
55	0	0	0	0	0	0	0	1	1	0
56	0	0	0	0	0	0	0	0	0	0
57	1	0	0	1	1	0	0	0	0	0
58	0	0	0	0	0	0	1	1	0	0
59	0	0	0	0	0	0	0	0	0	0
60	0	0	1	1	0	0	0	0	0	0
61	0	0	0	0	0	1	1	0	0	1
62	0	0	0	0	0	0	0	0	0	0
63	0	1	1	0	0	0	0	0	0	0
64	0	0	0	0	1	1	0	0	1	1
65	0	0	0	0	0	0	0	0	0	0
66	1	1	0	0	0	0	0	0	0	0
67	0	0	0	1	1	0	0	1	1	1
68	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0
70	0	0	1	1	0	0	1	1	1	0
71	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0
73	0	1	1	0	0	1	1	1	0	0
74	0	0	0	0	0	0	0	0	0	1
75	0	0	0	0	0	0	0	0	0	0
+	S461	S462	S463	S464	S465	S466	S467	S468	S469	S470
1	0	0	0	0	0	0	0	0	0	0
2	1	0	0	1	1	0	0	0	0	0
3	0	0	0	0	0	0	1	1	1	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	1	1	0	0	0	0	0	0
6	0	0	0	0	0	1	1	1	0	0

7	0	0	0	0	0	0	0	0	0	0
8	0	1	1	0	0	0	0	0	0	0
9	0	0	0	0	1	1	1	0	0	1
10	0	0	0	0	0	0	0	0	0	0
11	1	1	0	0	0	0	0	0	0	0
12	0	0	0	1	1	1	0	0	1	1
13	0	0	0	0	0	0	0	0	0	0
14	1	0	0	0	0	0	0	0	0	0
15	0	0	1	1	1	0	0	1	1	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	1	1	1	0	0	1	1	0	0
19	0	0	0	0	0	0	0	0	0	1
20	0	0	0	0	0	0	0	0	0	0
21	1	1	1	0	0	1	1	0	0	0
22	0	0	0	0	0	0	0	0	1	1
23	0	0	0	0	0	0	0	0	0	0
24	1	1	0	0	1	1	0	0	0	0
25	0	0	0	0	0	0	0	1	1	0
26	0	0	0	0	0	0	0	0	0	0
27	1	0	0	1	1	0	0	0	0	0
28	0	0	0	0	0	0	1	1	0	0
29	0	0	0	0	0	0	0	0	0	0
30	0	0	1	1	0	0	0	0	0	0
31	0	0	0	0	0	1	1	0	0	1
32	0	0	0	0	0	0	0	0	0	0
33	0	1	1	0	0	0	0	0	0	0
34	0	0	0	0	1	1	0	0	1	1
35	0	0	0	0	0	0	0	0	0	0
36	1	1	0	0	0	0	0	0	0	0
37	0	0	0	1	1	0	0	1	1	1
38	0	0	0	0	0	0	0	0	0	0
39	1	0	0	0	0	0	0	0	0	0
40	0	0	1	1	0	0	1	1	1	0
41	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0	0
43	0	1	1	0	0	1	1	1	0	0
44	0	0	0	0	0	0	0	0	0	1
45	0	0	0	0	0	0	0	0	0	0
46	1	1	0	0	1	1	1	0	0	0
47	0	0	0	0	0	0	0	0	1	1
48	0	0	0	0	0	0	0	0	0	0
49	1	0	0	1	1	1	0	0	0	0
50	0	0	0	0	0	0	0	1	1	1
51	0	0	0	0	0	0	0	0	0	0
52	0	0	1	1	1	0	0	0	0	0
53	0	0	0	0	0	0	1	1	1	0
54	0	0	0	0	0	0	0	0	0	0
55	0	1	1	1	0	0	0	0	0	0
56	0	0	0	0	0	1	1	1	0	0
57	0	0	0	0	0	0	0	0	0	0
58	1	1	1	0	0	0	0	0	0	0
59	0	0	0	0	1	1	1	0	0	1
60	0	0	0	0	0	0	0	0	0	0

61	1	1	0	0	0	0	0	0	0	0
62	0	0	0	1	1	1	0	0	1	1
63	0	0	0	0	0	0	0	0	0	0
64	1	0	0	0	0	0	0	0	0	0
65	0	0	1	1	1	0	0	1	1	0
66	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0
68	0	1	1	1	0	0	1	1	0	0
69	0	0	0	0	0	0	0	0	0	1
70	0	0	0	0	0	0	0	0	0	0
71	1	1	1	0	0	1	1	0	0	0
72	0	0	0	0	0	0	0	0	1	1
73	0	0	0	0	0	0	0	0	0	0
74	1	1	0	0	1	1	0	0	0	0
75	0	0	0	0	0	0	0	1	1	1
+	S471	S472	S473	S474	S475	S476	S477	S478	S479	S480
1	0	0	0	0	0	1	1	1	0	0
2	0	0	0	0	0	0	0	0	0	0
3	0	1	1	0	0	0	0	0	0	0
4	0	0	0	0	1	1	1	0	0	1
5	0	0	0	0	0	0	0	0	0	0
6	1	1	0	0	0	0	0	0	0	0
7	0	0	0	1	1	1	0	0	1	1
8	0	0	0	0	0	0	0	0	0	0
9	1	0	0	0	0	0	0	0	0	0
10	0	0	1	1	0	0	0	1	1	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0
13	0	1	1	0	0	0	1	1	0	0
14	0	0	0	0	0	0	0	0	0	1
15	0	0	0	0	0	0	0	0	0	0
16	1	1	0	0	1	1	1	0	0	0
17	0	0	0	0	0	0	0	0	1	1
18	0	0	0	0	0	0	0	0	0	0
19	1	0	0	1	1	1	0	0	0	0
20	0	0	0	0	0	0	0	1	1	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	1	1	1	0	0	0	0	0
23	0	0	0	0	0	0	1	1	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	1	1	1	0	0	0	0	0	0
26	0	0	0	0	0	1	1	0	0	1
27	0	0	0	0	0	0	0	0	0	0
28	1	1	1	0	0	0	0	0	0	0
29	0	0	0	0	1	1	0	0	1	1
30	0	0	0	0	0	0	0	0	0	0
31	1	1	0	0	0	0	0	0	0	0
32	0	0	0	1	1	0	0	1	1	1
33	0	0	0	0	0	0	0	0	0	0
34	1	0	0	0	0	0	0	0	0	0
35	0	0	1	1	1	0	1	1	1	0
36	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0
38	0	1	1	1	0	1	1	1	0	0

39	0	0	0	0	0	0	0	0	0	1
40	0	0	0	0	0	0	0	0	0	0
41	1	1	1	0	0	1	1	0	0	0
42	0	0	0	0	0	0	0	0	1	1
43	0	0	0	0	0	0	0	0	0	0
44	1	1	0	0	1	1	0	0	0	0
45	0	0	0	0	0	0	0	1	1	1
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Vita

Captain Marianne Idzi was born September 26, 1962, in Baltimore, Maryland. She graduated from Dundalk Senior High School in Baltimore County in 1980. In 1984, she graduated with a Bachelor of Science in Mathematics from the U.S. Air Force Academy. Then, in 1987, she received a Masters of Science in Systems Management from the University of Southern California.

Upon graduating from the Air Force Academy, she received a regular commission in the U.S. Air Force and served her first assignment at Sunnyvale Air Force Station in California as a Space Operations Satellite Officer. Here she received intensive training and experience to support the Global Positioning System Satellite. In 1986, she was assigned to Falcon Air Force base in Colorado Springs, Colorado where she helped activate the First Satellite Control Squadron (now known as the First Space Operations Squadron).

In 1989, Captain Idzi was selected to be an Assistant Professor of Aerospace Studies (AFROTC instructor) at Texas A&M University. There she was responsible for instructing and motivating over 900 potential Air Force Officers. In May 1992, Captain Idzi entered the Graduate School of Engineering at the Air Force Institute of Technology. Upon graduation in December 1983, she will be assigned to the 45 Range Operations Squadron, Shuttle Branch, at Cape Canaveral Air Force Station, Florida.

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13. ABSTRACT *(Maximum 200 words)*

The mission of Space Operations Squadrons is continuous support of military satellite systems. The scheduling problem associated with conducting continuous operations is threefold. The first problem is finding cyclical crew shift schedules that meet daily manning requirements, adhere to current regulations, contain a minimum number of workshift changes during consecutive duty days, and maximize the non-duty time allowed between duty shifts. The second problem is to establish a set of criteria to evaluate alternative shift schedules. Finally, the third problem is to minimize the number of personnel required to meet the scheduling requirements stated in the first problem. This study developed mathematical relationships that led to an approach for generating cyclical crew shift schedules. This method was used to generate an alternate crew shift schedule which was compared to the current schedule using a set of criteria developed for determining the effectiveness of a schedule. The alternate schedule is deemed better than the current schedule used by the First Space Operations Squadron. In addition, this study tested if non-crew scheduling could reduce the number of people needed to support satellite operations. Non-crew scheduling was modeled as a set covering problem. The set covering method shows that the scheduling requirements can be met using a smaller number of personnel.

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